EXHIBIT 5

IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
SHERMAN DIVISION

WAPP TECH LIMITED PARTNERSHIP and WAPP TECH CORP., Plaintiffs, v. SEATTLE SPINCO, INC. ET AL., Defendants.	Case No. 4:18-CV-00469-ALM **JURY TRIAL DEMANDED**
WAPP TECH LIMITED PARTNERSHIP and WAPP TECH CORP., Plaintiffs, v. WELLS FARGO & CO., Defendant.	Case No. 4:18-CV-00501-ALM **JURY TRIAL DEMANDED**
WAPP TECH LIMITED PARTNERSHIP and WAPP TECH CORP., Plaintiffs, v. BANK OF AMERICA CORP., Defendant.	Case No. 4:18-CV-00519-ALM **JURY TRIAL DEMANDED**

DECLARATION OF MATTHEW B. SHOEMAKE PH.D.

EXHIBIT
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I. INTRODUCTION

1. My name is Matthew B. Shoemake, Ph.D. I have been retained as a technical expert by counsel for Defendants in case numbers 4:18-cv-00469-ALM, 4:18-cv-00501-ALM, and 4:18-cv-00519-ALM to address certain issues concerning U.S. Patent Nos. 8,924,192 ("the '192 Patent"), 9,298,864 ("the '864 Patent"), and 9,971,678 ("the '678 Patent") (collectively, the "Asserted Patents") asserted by Plaintiffs Wapp Tech Limited Partnership and Wapp Tech Corp. (collectively, "Wapp" or "Plaintiffs"). Unless otherwise stated, the matters contained in this declaration are of my own personal knowledge and, if called as a witness, I could and would testify competently and truthfully with regard to the matters set forth herein.

2. My opinions are based on my years of education, research and work experience, as well as my investigation and study of relevant materials. A list of materials considered for purposes of this declaration is included in **Exhibit A** to my declaration.

3. I may rely upon these materials, my knowledge and experience, and/or additional materials in forming any necessary opinions. Further, I may also consider additional documents and information to address any issues, arguments, or opinions raised by Plaintiffs. I reserve any right that I may have to supplement this declaration if further information becomes available or if I am asked to consider additional information. Furthermore, I reserve any right that may exist to consider and comment on any additional expert statements or testimony of Plaintiffs' expert(s) (if any) in this matter. I also reserve the right to create exhibits and demonstratives to use in Court if called upon to testify.

II. BACKGROUND AND QUALIFICATIONS

4. I graduated *magna cum laude* from Texas A&M University with Bachelor's Degrees in Electrical Engineering and Computer Science. I also have a Master's Degree and a Ph.D. in Electrical Engineering from Cornell University. I presently serve on the External

Advisory Committee for the Texas A&M University Department of Electrical and Computer Engineering. I have many years of experience using simulators during my academic work. For example, both my masters and Ph.D. thesis focused on the field of error correction coding, a field that depends heavily on simulation to determine the performance of software for encoding and decoding signals. These simulations were frequently conducting using a program named Matlab. Matlab is a windows-based program for mathematical computation. It enables control and authoring of simulation via windows. The simulations can be authored in a way to show results of the simulation simultaneously as the simulation runs or to wait to display results when the overall simulation has completed. I authored both types of simulations using Matlab in the period 1994-1999 while at Cornell.

5. Beginning in August 1991 and continuing through the summer of 1995, I worked numerous semesters and summers as an engineering intern and engineer in the DSP Group at Texas Instruments ("TI") in Stafford, TX. While working at TI, I had significant exposure to, worked on designs for, and had hands-on experience with, simulators and emulators and simulation and emulation technology. (I explain simulation and emulation in more detail below.) For example, during my time at TI, I worked on software simulators and emulators for TI's TMS320C2x and TMS320C3x Digital Signal Processors ("DSP") products. The simulators were capable of executing software in a non-real-time fashion. That is, they were not able to operate at the same speeds that the software would operate at if it were run on an actual target DSP chip. Likewise, the simulators did not output results as the simulation was being conducted. The simulator ran via the use of a window, but the results did not display in the window in real-time as the simulation was performed. Only after the simulation was completed did the window update and show the results of the simulation. In addition to not being capable of operating at

full speed, the simulators did not have the input-output ("I/O") features of the actual DSP chips. In other words, the simulator was not as fast as the actual DSP chips, and the simulator did not receive inputs or provide outputs in the same form as the actual DSP chips. I also worked on emulators for TI's DSP chips. Unlike the simulators, those emulators were able to run at full speed and had the same I/O features of the actual DSP chips.

6. With respect to the simulators and emulators I worked with at TI, the emulators were generally more expensive than the simulators. However, the emulators were generally more sophisticated than the simulators in that they enabled functionality and operation identical to what would be achieved in a real-world end product that contained the DSP chip and associated software running on it.

7. Shortly after I received my M.S. in Electrical Engineering, in 1997, I joined the founding team of Alantro Communications, Inc., a manufacturer of semiconductor products. While employed by Alantro, I served as an engineer and engineering manager in the development of HDSL2 modems, cable modems, 2.4 GHz cordless phones and Wi-Fi technologies.

8. While obtaining my M.S. and Ph.D. degrees from Cornell and while working at Alantro Communications and TI, I frequently simulated the performance of communication systems algorithms and software to test and model the performance of the algorithms as implemented in software. These simulations were not identical to the algorithms as implemented in actual products such as Wi-Fi, DSL and cable modem products, but they served to model the performance of those algorithms.

9. TI acquired Alantro in 2000. I had by that time completed my Ph.D., and became the manager of TI's Wireless Networking Branch in TI's DSP Solutions R&D Center from 2000

to 2003. While manager of this group, I developed technologies for quality of service in Wi-Fi networks as well as Bluetooth and Wi-Fi coexistence technology. Throughout my time at TI, I worked with several different simulators and emulators to test the Wi-Fi and Bluetooth technologies I was working on. For example, I used OpNet and Matlab to simulate the performance of Wi-Fi and Bluetooth algorithms, and used FGPAs to emulate algorithms that were ultimate implemented in TI's production chips.

10. In 2003, I founded WiQuest Communications, Inc. and was the President and CEO of WiQuest from 2003 to 2008. At WiQuest, I developed and sold the world's first wireless docking system for notebook computers and the world's first 1 Gbps (one gigabit per second) ultrawideband chipset. I also developed the world's first wireless VGA/DVI system for notebook computers. This technology was incorporated into products developed by several major computer and electronics manufacturers such as Dell, Toshiba, Lenovo, Belkin, D-Link, and Kensington. I built the company from inception to 120 employees. I managed a diverse group of employees that were located in Texas, India, California, Taiwan, and Japan. During this period, I used simulators for simulating the performance of wireless USB physical layer algorithms and communications protocols. At WiQuest, we also emulated the actual performance of various algorithms using FPGAs prior to committing hardware designs to custom ASIC implementation.

11. In 2008, I founded Biscotti Inc. and served as its President and CEO through 2018. Biscotti built high-definition, Wi-Fi-based video calling systems for the home. At Biscotti, we used hardware development kits and prototypes to emulate the actual performance of our products prior to moving to full manufacturing of the final product.

12. Also in 2008, major companies began calling on me as a technical expert in patent litigation. After many years of working as a sole proprietor, I incorporated Peritum LLC in 2016 to continue my consulting work.

13. I am an inventor of a technology referred to as Packet Binary Convolutional Coding ("PBCC"), which was adopted as part of IEEE 802.11 (Wi-Fi) standards amendments, including 802.11b and 802.11g. PBCC was adopted into the IEEE 802.11 standard based at least in part on simulations that I performed that modeled its performance. I am a named inventor on over 30 patents.

14. Further relevant experience is set forth and discussed in my curriculum vitae attached hereto as **Exhibit B**.

III. COMPENSATION

15. I am being paid the rate of $540 per hour for my work on this case. My compensation does not depend on my testimony rendered or on the outcome of this case.

IV. SCOPE OF OPINIONS

16. I have been asked to provide certain opinions that relate to what I understand to be claim construction issues in this case. I have been asked to provide my opinions regarding the meaning of certain disputed claim terms as understood by one of ordinary skill as of the date on which the earliest application to which the Asserted Patents claim priority was filed, which I understand is claimed on the face of the Asserted Patents to be June 10, 2005.[1] My opinions are based in part on my understanding of the disputed claim terms and the parties' proposed constructions, and the evidence cited by the parties, as of when I executed this declaration.

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[1] I understand that Wapp is currently asserting infringement of claims 1-3 of the '192 Patent, claims 1-3, 26, 37, 45-50 of the '678 Patent, and claims 1-3, 8-12, 20, 29 of the '864 Patent.

V. LEGAL STANDARDS

17. Certain legal principles that relate to my opinions have been explained to me by counsel and are set forth below.

18. I understand that claim terms should generally be given their ordinary and customary meaning. I understand that the ordinary and customary meaning of a claim term is the meaning that the term would have to a person of ordinary skill in the art at the time of the effective filing date of the application for patent. As referenced above and described below, the Asserted Patents purport to claim priority to a provisional application filed on June 10, 2005.

19. I understand that, to properly understand the meaning of claim terms, one should first consider the intrinsic evidence, which includes the claim language itself, the patent specification, and the patent's prosecution history. For example, the patent specification may show that the inventor used words or terms in a manner inconsistent with their plain and ordinary meaning. Specifically, I understand that where the specification reveals a special definition given to a claim term by the patentee that differs from the meaning it would otherwise possess, the inventor's lexicography governs.

20. I understand that the prosecution history of the patent may also provide guidance in construing a claim term. For example, the prosecution history may show that the patent applicant might have limited the scope of some or all of the claims during prosecution, either affirmatively or by implication. I understand that when a patentee makes clear and unequivocal statements before the Patent Office to distinguish prior art from the claim, those statements are binding and preclude a broader construction. I further understand that even where a statement made during prosecution does not rise to the level of a binding disclaimer of claim scope, that statement may still provide intrinsic record support that favors a narrower construction.

21. I understand that extrinsic evidence, such as dictionary definitions, textbooks, and primary literature can shed useful light on the relevant art but are less significant than the intrinsic record in determining the legally operative meaning of claim language.

22. I further understand that if, after applying all other available tools of claim construction, a claim is ambiguous, a court may construe the claim to preserve its validity.

VI. A PERSON HAVING ORDINARY SKILL IN THE ART

23. I have been asked to offer my opinion regarding the level of ordinary skill in the art with respect to the Asserted Patents.

24. In my opinion, a person of ordinary skill in the art ("POSITA") would have had an undergraduate degree in electrical engineering, computer science, or computer engineering, or a related field, and at least one year of experience in the development and testing of software. This description is approximate, and a higher level of education or skill might make up for less experience, and vice-versa. Under this description, I qualified as a POSITA as of June 10, 2005, which as noted above and described below, is the filing date of the provisional patent application to which the Asserted Patents purport to claim priority.

VII. BACKGROUND REGARDING THE ASSERTED PATENTS

25. The Asserted Patents are within a single family consisting of several patents. The application that led to the '192 Patent was filed on November 9, 2012 and is continuation of the application that led to U.S. Patent No. 8,332,203 (filed on April 13, 2010), which is a continuation of the application that led to U.S. Patent No. 7,813,910 (filed on June 9, 2006) ("the '910 Patent"). The application that led to the '678 Patent was filed on December 23, 2014 and is a continuation of the application that led to the '192 Patent. The application that led to the '864 Patent was filed on November 19, 2013. The application that led to the '864 Patent is a divisional of the application that led to U.S. Patent No. 8,589,140 (filed February 15, 2010) and a

continuation-in-part of the application that led to the '910 Patent. Each of the Asserted Patents on its face claims priority to U.S. Provisional Application No. 60/689,101 (filed June 10, 2005).

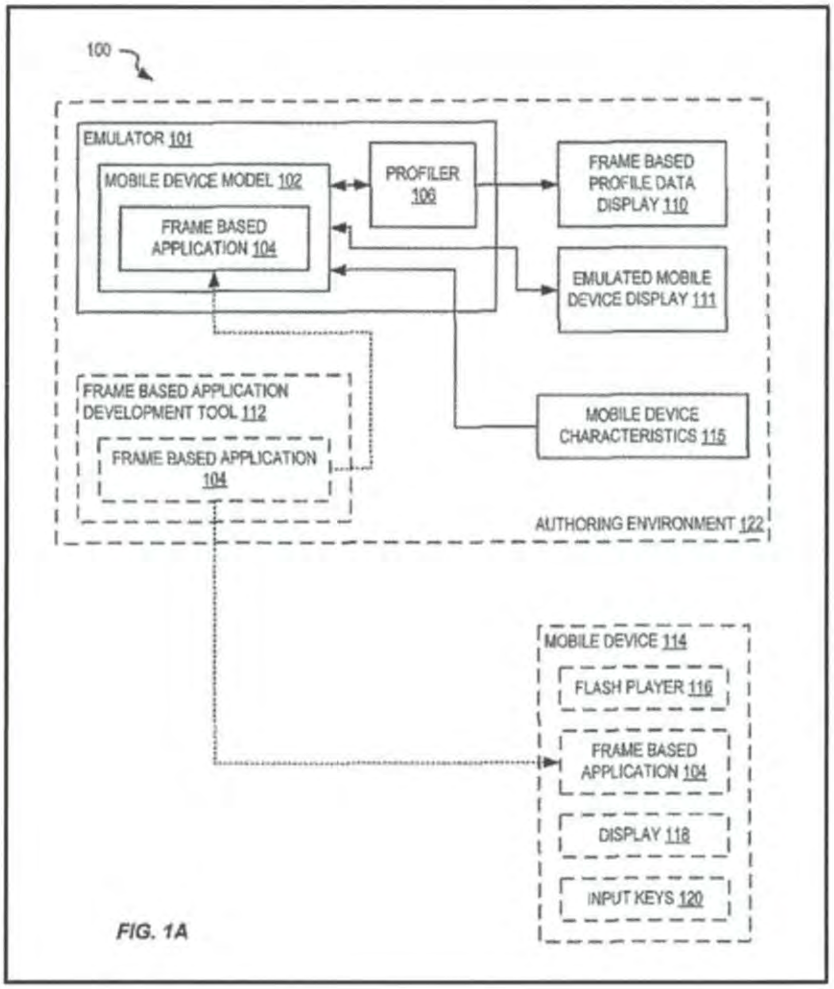
26. In their "BACKGROUND" sections, the Asserted Patents disclose that "[a]pplications for mobile devices are typically developed on a personal computer (PC) or workstation and target one or more types of mobile device that include a Flash Player." '192 Patent at 1:40-42; '678 Patent at 1:39-42; '864 Patent at 1:34-37. But these applications "require real-time testing of the application on all applicable mobile devices" because, for example, while a "Flash Player application may operate correctly on one mobile device model, it may crash when playing on a different mobile device model." '192 Patent at 1:42-46; '678 Patent at 1:42-46; '864 Patent at 1:37-45. "Development packages (e.g., FlashMX by Macromedia) are available to run on a PC and allow development of Flash Player applications for one or more mobile devices," but these development packages "do not determine if the application will play correctly on the targeted mobile device based upon resource usage." '192 Patent at 1:52-58; '678 Patent at 1:52-59; '864 Patent at 1:51-57. According to the Asserted Patents, "[c]urrently, the only way to determine if an application plays on a particular mobile device is to transfer the application to the device and play it." '192 Patent at 1:58-61; '678 Patent at 1:59-61; '864 Patent at 1:57-60. But when "an application is targeted to play on many types of mobile device[s]," the "transferring and testing process is time-consuming and therefore costly for the application author." '192 Patent at 1:66-2:3; '678 Patent at 1:66-2:4; '864 Patent at 1:65-2:2. The Asserted Patents further state that "having accessibility to all available mobile devices in targeted geographical markets worldwide as well as real-time interaction with network Operators to measure and emulate network characteristics within each market is presently not possible." '192 Patent at 2:4-8; '678 Patent at 2:5-9; '864 Patent at 2:3-7.

27. In the "SUMMARY OF THE INVENTION" section, the Asserted Patents disclose that, "[i]n one embodiment, a method emulates and profiles an application to play on a mobile device that includes a Flash Player." '192 Patent at 2:13-15; '678 Patent at 2:13-15; '864 Patent at 2:11-13 (replacing "a Flash Player" with "an application player"). "Characteristics defining performance of the mobile device are loaded," and the "mobile device is emulated using a model based upon the characteristics." '192 Patent at 2:15-17; '678 Patent at 2:15-17; '864 Patent at 2:13-15. The Asserted Patents further disclose that the "application is played and monitored within the model to determine resource utilization of the application for the mobile device." '192 Patent at 2:17-19; '678 Patent at 2:17-19; '864 Patent at 2:15-17.

A. Emulating and Profiling a Frame Based Application

28. According to the Asserted Patents, FIG. 1A (all patents, below) "shows one exemplary embodiment of a system 100 for emulating and profiling a frame based application 104 playing on a mobile device 114 that includes a Flash Player 116." '192 Patent at 4:53-56; '678 Patent at 5:1-4; '864 Patent at 3:66-4:2. Also according to the Asserted Patents, system 100 includes an emulator 101 and a profiler 106. '192 Patent at 4:56-57; '678 Patent at 5:4-5; '864 Patent at 4:2-3. "Emulator 101 generates a mobile device model 102, based upon mobile device characteristics 115 of mobile device 114." '192 Patent at 4:57-59; '678 Patent at 5:5-7; '864 Patent at 4:3-5. "Model 102 emulates mobile device 114 to play frame based application 104 and may, for example, generate an emulated mobile device display 111 that represents mobile device 114." '192 Patent at 4:59-62; '678 Patent at 5:7-10; '864 Patent at 4:5-8. "Profiler 106 monitors playing of frame based application 104 within model 102 to estimate resource usage of application 104 and generates a frame based profile data display 110." '192 Patent at 4:66-5:1; '678 Patent at 5:15-18; '864 Patent at 4:28-30. "Frame based profile data display 110 may allow

a user of system 100 to identify areas within application 104 that would exceed resources of mobile device 114." '192 at 5:2-4; '678 Patent at 5:18-20; '864 Patent at 4:31-33.



29. According to the Asserted Patents, FIG. 2 (all patents, below) is a block diagram illustrating emulator 101. '192 Patent at 7:26-27; '678 Patent at 7:41-42; '864 Patent at 6:58-59. According to the Asserted Patents, emulator 101 is shown as including profiler 106, which includes "a processor profile module 202, a memory profile module 204, a graphic profile module 206 and a system profile module 208." '192 Patent at 7:27-30; '678 Patent at 7:42-45; '864 Patent at 6:59-62. The Asserted Patents further disclose that "Flash applications are based

upon a timeline of frames that may include graphical information and action scripts, FS Commands, network protocols, selected frame rate, etc." '192 Patent at 7:60-62; '678 Patent at 8:10-12; '864 Patent at 7:25-27. In FIG. 2, "application 104 is shown with a timeline 222 that includes frames 223." '192 Patent at 8:4-5; '678 Patent at 8:21-22; '864 Patent at 7:36-37. Each frame of frames 223 "may include graphics and/or action scripts that generate the graphical image for display." '192 Patent at 8:5-7; '678 Patent at 8:22-24; '864 Patent at 7:37-39. The Asserted Patents further disclose that "[i]f mobile device 114 has insufficient processor resources (e.g., because the animation is too complex for the targeted mobile device), application 104 may crash (i.e., cease to function correctly)." '192 Patent at 8:18-21; '678 Patent at 8:35-39; '864 Patent at 7:50-53. Thus, according to the Asserted Patents, "it is important to determine the 'stress' applied by application 104 to resources of mobile device 114." '192 Patent at 8:21-23; '678 Patent at 8:39-41; '864 Patent at 7:53-55.

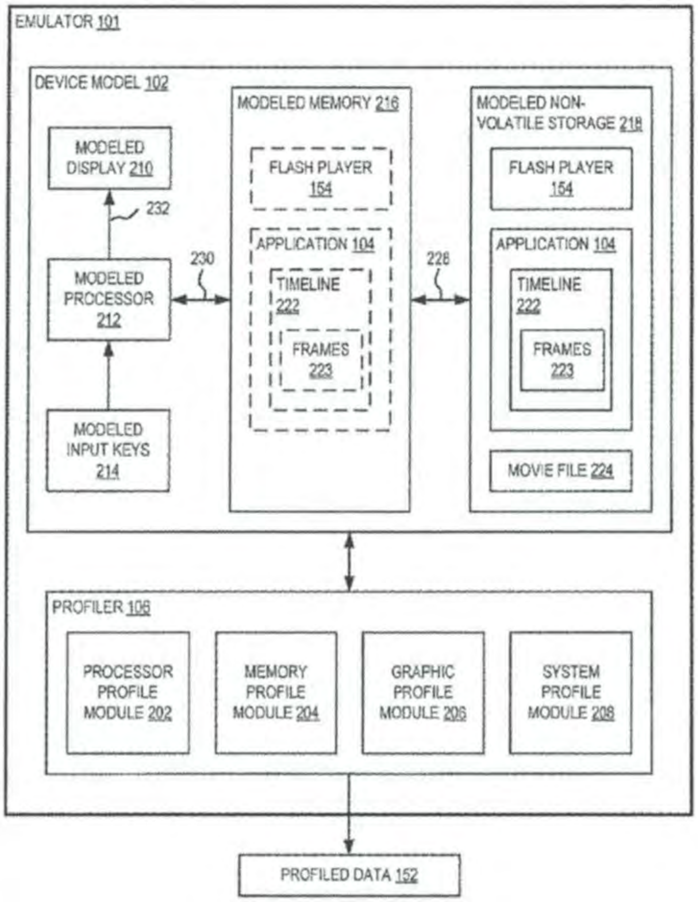


FIG. 2

30. According to the Asserted Patents, FIG. 3 (all patents, below) "shows one exemplary display 300 showing a frame based display of profiled data 152, FIG. 1A, determined by processor profile module 202." '192 Patent at 8:39-41; '678 Patent at 8:57-59; '864 Patent at 8:4-6. According to the Asserted Patents, display 300 is shown with "a time line 302 that represents timeline 222 of application 104" and "each bar 304 indicates processor resource utilization for certain frames 223 of application 104." '192 Patent at 8:41-45; '678 Patent at 8:59-63; '864 Patent at 8:6-14. "During play of application 104 within model 102, a current position indicator 306 shows the frame (i.e., frame 1 in this example) currently displayed by

emulated mobile device display 111 (see FIG. 4)." '192 Patent at 8:45-47; '678 Patent at 8:63-66; '864 Patent at 8:14-17. The Asserted Patents further disclose that "[w]here bars 304 rise above capacity line 308 at locations 310, resource utilization for indicated frames of application 104 exceed the available processor resources of mobile device 114; thus application 104 may 'capout' or crash when playing those frames." '192 Patent at 8:50-54; '678 Patent at 9:1-5; '864 Patent at 8:19-23.

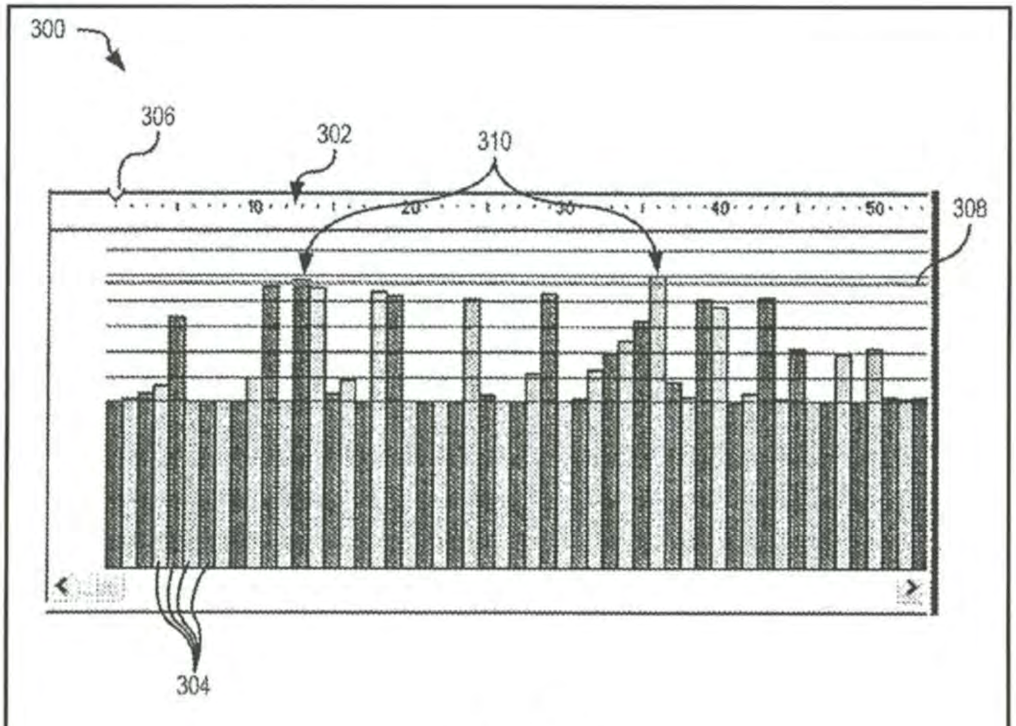


FIG. 3

B. Simulated Network Characteristics

31. The Asserted Patents disclose that "[s]imulated network operation is described in further detail below and shown in FIGS. 8 though [*sic*] 13." '192 Patent at 10:23-25; '678 Patent at 10:42-44; '864 Patent at 10:1-3. FIG. 8 (all patents, below) of the Asserted Patents "is a block diagram illustrating interaction of emulator 101 with an operator development server 808 via Internet 822 for simulating playing of application 104 within a mobile device connected to a

wireless network (e.g., a mobile phone wireless network)." '192 Patent at 10:30-34; '678 Patent at 10:49-53; '864 Patent at 10:8-12. The Asserted Patents further disclose that "FIGS. 9, 10, 11 and 12 show exemplary windows that allow a user to interact with emulator 101 for configuring and testing operation of application 104 within model 102 when simulating connection to a wireless network." '192 Patent at 10:34-38; '678 Patent at 10:53-57; '864 Patent at 10:12-16. I have reproduced FIG. 9 of the Asserted Patents below.

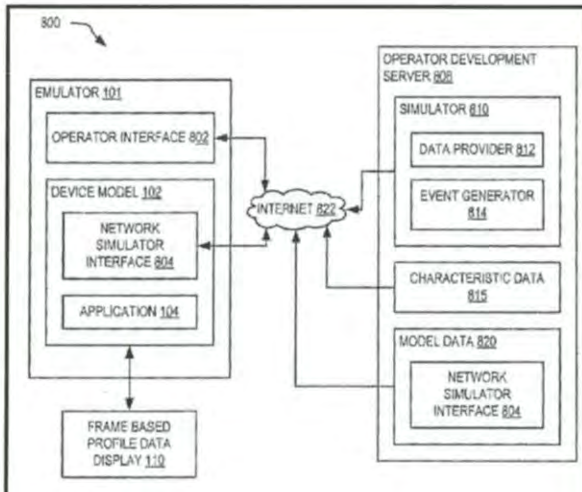


FIG. 8

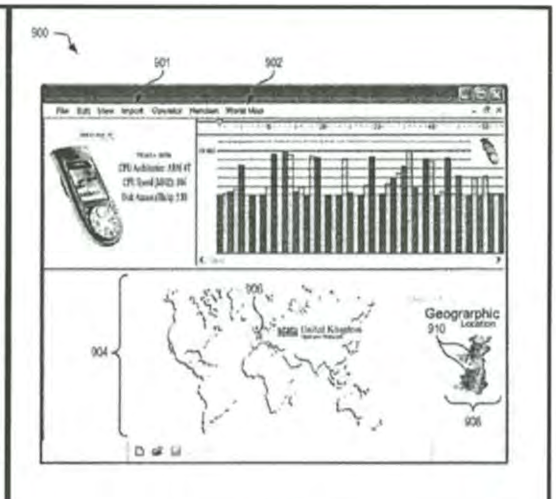


FIG. 9

32. In FIG. 8 of the Asserted Patents, "[e]mulator 101 is shown with an operator interface 802 that interacts with operator development server 808 via Internet 822." '192 Patent at 10:40-42; '678 Patent at 10:59-61; '864 Patent at 10:18-20. Operator development server 808 "is shown with a simulator 810, characteristic data 815 and model data 820." '192 Patent at 10:44-45; '678 Patent at 10:63-65; '864 Patent at 10:22-23. As shown in FIG. 8 of the Asserted Patents, emulator 101 includes network simulator interface 804 that "includes functionality that allows device model 102 to communicate with simulator 810 to simulate

connectivity of mobile device 114 with a wireless network." '192 Patent at 11:7-11; '678 Patent at 11:28-31; '864 Patent at 10:53-57.

33. According to the Asserted Patents, "Simulator 810 is shown with a data provider 812 and an event generator 814." '192 Patent at 11:28-30; '678 Patent at 11:49-50; '864 Patent at 11:7-8. Data provider 812 may "simulate data transfers within a wireless network." '192 Patent at 11:29-30; '678 Patent at 11:50-51; '864 Patent at 11:8-9. "Event generator 814 may, for example, generate certain events (e.g., incoming calls, incoming text messages, etc) that occur within a wireless network." '192 Patent at 11:32-35; '678 Patent at 11:53-56; '864 Patent at 11:11-14.

34. According to the Asserted Patents, FIG. 12 (all patents, below) shows a window 1200 that "is displayed to allow the user to select desired network characteristics for simulation." '192 Patent at 12:1-2; '678 Patent at 12:23-25; '864 Patent at 11:48-50. More specifically, according to the Asserted Patents, "[w]indow 1200 shows a pull-down list 1202 of network characteristics that may be simulated by simulator 810," including for example, "control of scripted events (e.g., cell tower identification, service message, bandwidth, etc.), consumer events (e.g., checking email, checking messages, browsing network, available minutes, selecting images, etc.) and incoming events (e.g., phone calls, WAP Messages, receiving MMS, receiving SMS, etc.)." '192 Patent at 12:3-11; '678 Patent at 12:26-33; '864 Patent at 11:51-58.

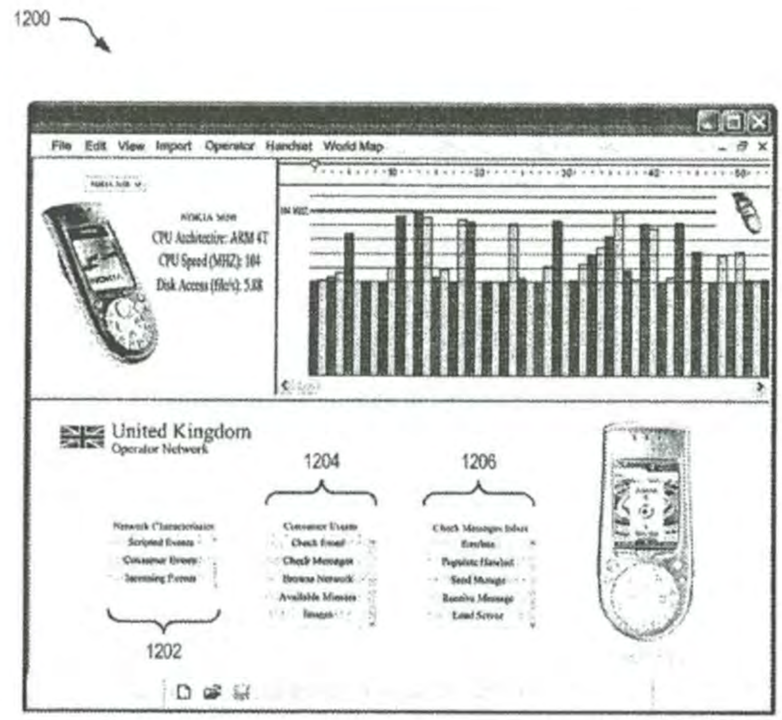


FIG. 12

VIII. THE "EMULATE" AND "SIMULATE" CLAIM TERMS

35. I have been asked to opine as to how a POSITA in June 2005 would have understood the terms "emulate" and "simulate" in the context of the intrinsic record of the Asserted Patents. I note that Plaintiffs have not set forth proposed constructions for "simulate" or "emulate," and therefore Plaintiffs have not provided proposed constructions to these terms to which I can respond in this declaration. Instead, I have been informed that Plaintiffs set forth the following for their "Preliminary Construction" for both "simulate" and "emulate": "No construction necessary." I reserve any right I may have to respond to any proposed construction(s) of "simulate" and/or "emulate" that Plaintiffs later put forth.

A. "Emulate"

36. I understand that Defendants have proposed construing "emulate" as "mimic." I agree with this proposed construction because it accurately reflects how a POSITA would have understood "emulate" in view of the intrinsic record. A POSITA would have understood that, to test a software application, the application can be executed in an environment that "emulates" the conditions that the application may experience and/or the device on which the application is executed. A POSITA would understand that in that environment, the target conditions and/or device would be represented with hardware and/or software components that model the target conditions relatively precisely as compared to "simulations," which I describe below. I refer to this relatively precise representation as "mimicking" a target.

37. Consistent with the plain meaning of "emulate," the Asserted Patents use this term (and its variants) to describe mimicking a target. Indeed, as explained above, the very alleged purpose of the alleged invention at a general level was to allow a developer of a mobile application to test how that application would run on a particular mobile device under certain circumstances (*e.g.*, involving network characteristics), and to profile certain resource utilization information while the application would be running, *without* needing access to an actual physical unit of the mobile device. '192 Patent at 1:61-2:8, 14:1-33; '678 Patent at 1:61-2:9, 14:28-47; '864 Patent at 1:60-2:7, 13:48-65. Thus, the "emulation" described in the Asserted Patents refers to mimicking the real-world mobile device with such precision so as to allow the application to be played on the device, and the resource utilization of the mobile device to be profiled, as if a real, physical unit were running the application. In my opinion, this is consistent with, and supports, Defendants' proposed construction of "mimic."

38. The Asserted Patents consistently describe emulation as mimicking a target. For example, the Asserted Patents state that "[t]he user interacts with emulated mobile device

display 111 to control application 104 as if application were running on device 114." '192 Patent at 8:35-38; '678 Patent at 8:54-56; '864 Patent at 8:1-3. In my opinion, enabling a user to interact with an "emulated mobile device display" so that the interaction is "as if [the] application were running on device 114" is consistent with a POSITA's understanding of emulating as mimicking.

39. In addition, the Asserted Patents disclose that Table 1 (all patents, below) "shows exemplary characteristics that may be used to specify performance of model 102 to emulate mobile device 114." '192 Patent at 6:11-12; '678 Patent at 6:21-22; '864 Patent at 5:36-37. In my opinion, a POSITA would have recognized that the characteristics set forth in Table 1 of the Asserted Patents are precise characteristics of the target mobile device (*i.e.*, the NOKIA 3650), as opposed to the characteristics the Asserted Patents describe with respect to simulations, which I describe below. *See also* '192 Patent at 6:12-47 (describing the characteristics listed in Table 1); '678 Patent at 6:22-59 (same); '864 Patent at 5:37-6:9 (same). For example, Table 1 specifically defines the "ARM 4T" processor having a "Processor Speed" of 104 MHz and a "Storage Access Speed" of 5.88 files/second. That the Asserted Patents do not round either of these values (*e.g.*, to 100 MHz or 6 files/second, respectively) would have further indicated to a POSITA that the given values are precise. Further, the fact that the specific ARM processor architecture, "4T,"[2] is provided would also indicate to a POSITA that the model is precisely capturing the characteristics and capabilities of the specific processor. Table 1 further provides similarly specific values for the "Display Width" and the "Display Height" (256 and 394, respectively).

[2] "ARMv4T" is a specific ARM architecture.

TABLE 1

Mobile Device Characteristics	
Parameter	Value
Name	NOKIA 3650
Processor	ARM 4T
Processor Speed	104 MHz
Storage Access Speed	5.88 files/second
RAM Size	256 MB
Storage Size	512 MB
Display Width	256
Display Height	394

TABLE 1-continued

Mobile Device Characteristics	
Parameter	Value
Pixel Depth	24
Processor Availability	60%
RAM Availability	60%
Storage Availability	40%

40. According to the Asserted Patents, FIG. 5 (all patents, below) of the Asserted Patents "shows one exemplary window 500 that includes display 300 of FIG. 3 and display 400 of FIG. 4 and an exemplary user interface." '192 Patent at 9:5-7; '678 Patent at 9:24-26; '864 Patent at 8:45-47. The Asserted Patents disclose that window 500 "shows selection of a mobile device (i.e., NOKIA 3650 in this example)" (i.e., the target for the emulation) from a "pull-down list 502 that results in display of characteristics 504 of the selected mobile device." '192 Patent at 9:7-10; '678 Patent at 9:26-29; '864 Patent at 8:47-51. As illustrated below, characteristics 504 provide the detailed processor-related characteristics shown in Table 1, *i.e.*, "CPU Architecture: ARM 4T," "CPU Speed (MHZ): 104," and "Disk Access (file/s): 5.88."

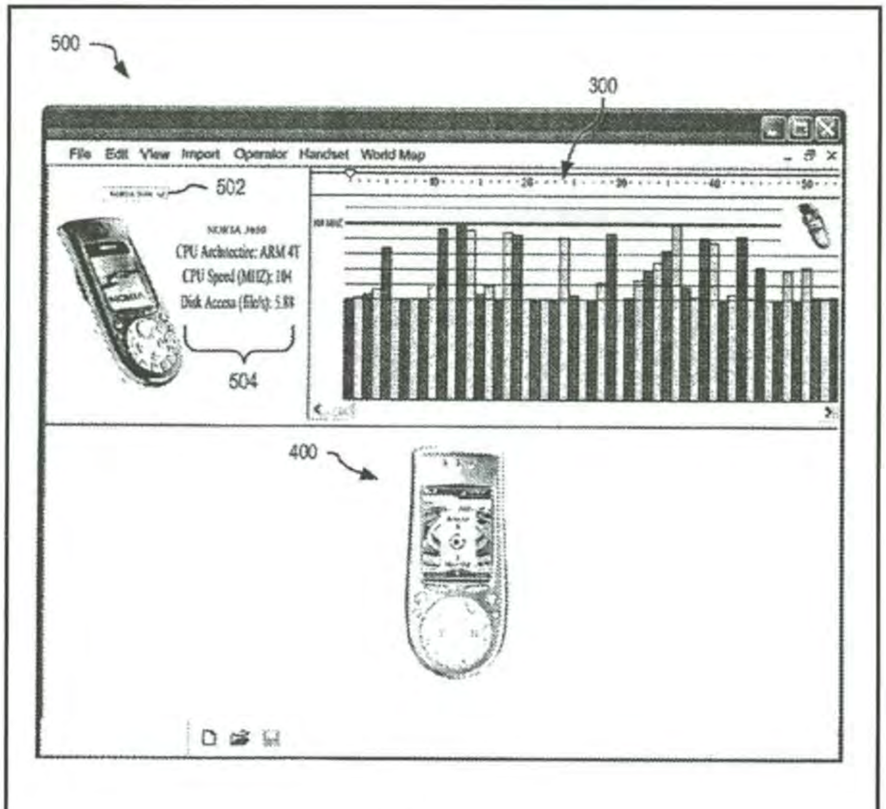


FIG. 5

41. Additionally, the Asserted Patents describe emulation as something that is precise enough to enable a profiler to analyze resource utilization on a target mobile device. In my opinion, a POSITA would understand that a "profiler" is a "diagnostic tool for analyzing the run-time behavior of programs." *Microsoft Computer Dictionary* 424 (5th Ed. 2002) (DEF009158) (attached as **Exhibit C**). Consistent with that understanding, the Asserted Patents describe emulator 101 as including profiler 106, which includes a processor profile module 202, a memory profile module 204, a graphic profile module 206 and a system profile module 208. '192 Patent at 7:27-30; '864 Patent at 6:58-62; '678 Patent at 7:42-45. The Asserted Patents describe each of these "profile" modules as estimating detailed characteristics that a POSITA would have recognized would vary from one mobile device to another:

> Processor profile module 202 may, for example, estimate processor utilization of application 104 within model 102. Memory profile module 204 may, for example, estimate memory utilization by application 104 within model 102. Graphic profile module 206 may, for example, estimate utilization of 3D fill rate and 3D polygon count of application 104 within model 102. System profile module 208 may, for example, determine overall system utilization of application 104 within model 102.

'192 Patent at 7:30-39; '864 Patent at 6:62-7:4; '678 Patent at 7:45-54. The above-quoted passage discloses that each of the modules of profiler 106 estimates information based on "application 104 within model 102." It follows therefore, that the model 102, which is what emulator 101 uses to conduct the emulation, must represent the processor, memory, graphics, and system characteristics of the target with sufficient detail so as to enable the estimation. Otherwise, the estimations output by modules 202-208 would be effectively meaningless.

42. The tracking and display of resource utilization described in the Asserted Patents further indicates that a POSITA would have understood "emulate" to mean "mimic." For example, describing the display shown in FIG. 3, the Asserted Patents describe the ability to set a "capacity line 308 (capout)" that "indicates the maximum processor resource available to application 104" based on the mobile device being emulated. '864 Patent at 8:17-19; '192 Patent at 8:48-50; '678 Patent at 8:66-9:1. Further, "[w]here bars 304 rise above capacity line 308 at locations 310, resource utilization for indicated frames of application 104 exceed the available processor resources of mobile device 114; thus application 104 may 'capout' or crash when playing those frames." '192 Patent at 8:50-54; '678 Patent at 9:1-5; '864 Patent 8:19-24. In order to determine precisely "those frames" for which the application exceeds the available processor resources of the mobile device, a POSITA would recognize that emulator 101 must be utilize a precise representation of the target mobile device.

43. Contemporaneous extrinsic evidence further supports the understanding that "emulate" would have meant "mimic." For example, the Microsoft Computer Dictionary defines

"emulate" as "[f]or a hardware or software system to behave in the same manner as another hardware or software system." *Microsoft Computer Dictionary* 191 (5th Ed. 2002) (DEF009157) (attached as **Exhibit C**). In the context of "Comp," the Chambers Dictionary of Science and Technology defines "emulator" as "[a] program which causes one computer to behave as if were another type of computer; eg a computer may emulate an IBM-compatible one." *Chambers Dictionary of Science and Technology* 395 (1999) (emphasis in original) (DEF009144) (attached as **Exhibit D**). The Wiley Electrical and Electronics Engineering Dictionary defines "emulator" as "[c]omputer hardware and/or software which is designed to work exactly like another." *Wiley Electrical and Electronics Engineering Dictionary* 256 (2004) (DEF009178) (attached as **Exhibit E**). Que's Computer User's Dictionary defines "emulation" as "[t]he duplication of the functional capability of one device in another device." *Que's Computer User's Dictionary* 123 (1992) (DEF009170) (attached as **Exhibit F**). The New IEEE Standard Dictionary of Electrical and Electronics Terms defines "emulate" as "[t]o represent a system by a model that accepts the same inputs and produces the same outputs as the system represented." *The New IEEE Standard Dictionary of Electrical and Electronics Terms* 1226 (5th Ed. 1993) (DEF009172) (attached as **Exhibit G**).

B. "Simulate"

44. I understand that Defendants have proposed construing "simulate" as "imitate." I agree with this proposed construction because it accurately reflects how a POSITA would have understood "simulate" in view of the intrinsic record. A POSITA would have understood that, to test a software application, the application can be executed in an environment that "simulates" the conditions that the application may experience and/or the device on which the application is executed. A POSITA would understand that in that environment, the conditions or performance to be simulated would be represented or implemented using a model of the target conditions, and

the model would, in general, be relatively imprecise as compared to emulation in that it generally would not fully capture all aspects of the conditions being simulated. This is as opposed to "emulations," as described above. As an example, network conditions may be simulated in a relatively imprecise fashion that does not fully duplicate all aspects of a network's operation yet does suffice to enable modeling of certain operations such as receiving a message from a network. I refer to this relatively imprecise modeling and representation as "imitating" a target.

45. Another example that may be more familiar to the Court is hurricane modeling and simulation. Under my definition of "emulation" above, a hurricane cannot be "emulated" based on current technology. If such emulation were possible, we could precisely predict the path of a hurricane, location where the eye of a hurricane will come ashore, exact wind speeds, exact locations and strength of spawned tornados and speed of the hurricane. Such complete emulation is not feasible based on current technology; thus, meteorologists formulate models of hurricanes that allow simulations to be run that predict the behavior of a hurricane in what would generally be a relatively imprecise fashion.

46. Consistent with this plain meaning, the Asserted Patents use the term "simulate" (and its variants) to describe imitating a target. For example, with respect to FIG. 12 of the Asserted Patents (*see* Section VII.B, above), the Asserted Patents disclose that "pull-down list 1202" provides "network characteristics that may be simulated by simulator 810." '192 Patent at 12:3-4; '678 Patent at 12:26-27; '864 Patent at 11:51-52. "Based upon selection from list 1202, a second list may be presented to allow further simulation requirements to be entered." '192 Patent at 12:11-13; '678 Patent at 12:33-35; '864 Patent at 11:58-60. These "further simulation requirements" are relatively high-level characteristics used to simulate the chosen network characteristic. For example, the Asserted Patents disclose that if the user selects "consumer

events" from list 1202, the user can select relatively high-level characteristics of those "consumer events," *e.g.*, "check messages" (from pull-down list 1204) and "send message" (from pull-down list 1206). '192 Patent at 12:12-20; '678 Patent at 12:35-43; '864 Patent at 11:60-67. According to the Asserted Patents, once the user has specified the network event(s) that are of interest, the *simulation* of the *network* events can be executed by *simulator* 110 (without need to precisely model the entire network) while the *application* is running *on the emulator* (which does provide a precise environment that models the device's capabilities and resources). *See, e.g.*, '192 Patent at 13:7-16; '678 Patent at 13:31-34; '864 Patent at 12:54-57. A POSITA would have understood that a "consumer event" defined by the requirements of "check messages" and "send message" is a target that is represented with relatively imprecise characteristics (as opposed to the characteristics used to define an emulated mobile device, which I describe above).

47. Contemporaneous extrinsic evidence is consistent both with my description of the plain meaning of "simulate" and how the Asserted Patents use the term—*i.e.*, to "imitate." For example, the Microsoft Computer Dictionary from 2002 defines "simulation" as "[t]he imitation of a physical process or an object by a program that causes a computer to respond mathematically to data and changing conditions as though it were the process or object itself." *Microsoft Computer Dictionary* 482 (5th Ed. 2002) (DEF009159) (attached as **Exhibit C**). Similarly, the Wiley Electrical and Electronics Engineering Dictionary defines "simulation" as "[a]n imitation, model, or other representation of an object, situation, process, feature, manner of operation, or the like." *Wiley Electrical and Electronics Engineering Dictionary* 712 (2004) (DEF009179) (attached as **Exhibit E**). Other contemporary dictionaries supply definitions that are consistent with this usage, focusing on the "modeling" aspect of the term. *Chambers*

Dictionary of Science and Technology 1056 (1999) (DEF009145) (attached as **Exhibit D**) (in the context of "Comp, Electronics," defining "simulation" as "[t]he representation of physical systems and phenomena by computers, models and other equipment"); *Que's Computer User's Dictionary* 332 (1992) (DEF009171) (attached as **Exhibit F**) (defining "simulation" as "[a]n analytical technique used in computer applications, in which a phenomenon's properties are investigated by creating a model of the phenomenon and exploring the model's behavior"); *The New IEEE Standard Dictionary of Electrical and Electronics Terms* 1226 (5th Ed. 1993) (DEF009172) (attached as **Exhibit G**) (defining "simulate" in the context of "computing systems" as "[t]o represent the functioning of one system by another, for example, to represent one computer by another, to represent one physical system by the execution of a computer program, to represent a biological system by a mathematical model").

48. My opinions regarding a POSITA's understanding of "simulate" and "emulate" are consistent with, and are further confirmed by, my experience with simulation and emulation during my time at TI. TI designed and sold simulators and emulators for its digital signal processors, *e.g.*, the TMS320C3x DSP, which I described above (*see* Section II, above). The simulators could be used to test the performance of small portions of software code, but they were imprecise in that the simulators generally did not have real-world input/output capability and did not operate at full speed. Thus, the TMS320C3x DSP simulator could be used in the early development process when relatively high-level modeling and testing sufficed for software run on the DSP chips. However, when we needed a more detailed, real-world representation of performance of software on the TMS320C3x DSP, we would test the applications on the TMS320C3x DSP emulator. The emulator enabled the person conducting the test to feed the same inputs that would be provided to the target DSP chips and receive the same outputs as

would be provided by the target DSP chips. The emulator would further operate at full-speed, allowing testing of the software being developed with the same speed as the target DSP chips. The TMS320C3x DSPs were the predecessor to many later TI chips, including TI's Open Multimedia Applications Platform ("OMAP") processors, which went into mobile devices. For example, Nokia purchased the TI OMAP processors and included them in some of their mobile phones. The simulators and emulators for the TI OMAP processors were similar to the simulator and emulator I used for the TMS320C3x DSPs. To my knowledge, our use of the TMS320C3x DSP simulator and emulator was consistent with how others used these tools in the software development community.

IX. THE "SIMULATE/EMULATE, VIA ONE OR MORE PROFILE DISPLAY WINDOWS" LIMITATIONS

49. I have been asked to opine as to how a POSITA in June 2005 would have understood the following terms in view of the intrinsic record: "simultaneously visually emulate, via one or more profile display windows" (as recited in claim 1 of the '192 Patent); "simulate, via one or more profile display windows" (as recited in claim 1 of the '864 Patent); and "simultaneously visually simulate, via one or more profile display windows" (as recited in claims 1, 26, 37, and 45 of the '678 Patent). I refer to these limitations collectively as the "simulate/emulate, via one or more profile display windows" limitations. I note, however, that Plaintiffs have not set forth proposed constructions for the "simulate/emulate, via one or more profile display windows" limitations. Instead, I have been informed that Plaintiffs listed the following for their "Preliminary Construction" for the "simulate/emulate, via one or more profile display windows" limitations: "No construction necessary." I reserve any right I may have to respond to any construction(s) of the "simulate/emulate, via one or more profile display windows" limitations that Plaintiffs propose at a later date.

50. I understand that Defendants have proposed construing the "simulate/emulate, via one or more profile display windows" limitations as follows: 1) "simultaneously visually emulate, via one or more profile display windows" (as recited in claim 1 of the '192 Patent) to mean "mimic, while at the same time displaying one or more windows showing in real time resources of the mobile device that are available to the application as a result of the mimicked activity"; 2) "simulate, via one or more profile display windows" (as recited in claim 1 of the '864 Patent) to mean "imitate, and make available for display one or more windows showing resources of the mobile device that are available to the application as a result of the imitated activity"; and 3) "simultaneously visually simulate, via one or more profile display windows" (as recited in claims 1, 26, 37, and 45 of the '678 Patent) to mean "imitate, while at the same time displaying one or more windows showing in real time resources of the mobile device that are available to the application as a result of the imitated activity." I agree that Defendants' proposed constructions reflect how a POSITA would understand the "simulate/emulate, via one or more profile display windows" limitations in view of the intrinsic record.

51. Defendants' proposed constructions define "simulate" and "emulate" as "imitate" and "mimic," respectively, which as I have explained reflects how these terms would have been understood by a POSITA in view of the intrinsic record. (*See* Section VIII, above.) In addition, Defendants' proposed constructions reflect the understanding that the clause "via one or more profile display windows" refers to one or more windows displaying resources of the mobile device that are available to the application as a result of the imitated activity. Finally, claim 1 of the '192 Patent and claims 1, 26, 37, and 45 of the '678 Patent recite the phrase "simultaneously visually" as part of these terms. Under Defendants' proposed constructions, this phrase requires 1) that the one or more windows be displayed at the same time as when the simulation or

emulation is conducted and 2) that the one or more windows show results of the simulation or emulation in real time (*i.e.*, showing the resources of the mobile device that are available to the application as the emulation or simulation is conducted). Conversely, claim 1 of the '864 Patent does not recite "simultaneously visually," and as a result this construction only refers to making the one more windows available for display at some point (*e.g.*, in real time or at a later time). This is described more fully in Paragraph 54, below.

52. In my opinion, a POSITA would have understood that the "simulate/emulate via one or more profile display windows" limitations do not have a plain and ordinary meaning apart from the Asserted Patents. A POSITA would therefore need to look to the intrinsic record to understand the "simulate/emulate, via one or more profile display windows" limitations. For example, without reference to the Asserted Patents, a POSITA would not understand what it means to simulate or emulate "via" a "profile display window" or to "visually" simulate or emulate. A POSITA would have understood that "display windows" are portions of a visual display screen generated by a computer, used to present a visual output to a user. But in the Asserted Claims, the thing being "simulated" or "emulated"—which I refer to as the "target" of the simulation or emulation—is not a visual phenomenon. Rather, the target is either "a plurality of network characteristics" (claim 1 of the '192 Patent and claim 1 of the '864 Patent) or "a plurality of operator network characteristics" (claims 1, 26, 37, and 45 of the '678 Patent). The Asserted Patents describe network characteristics as either conditions of the network (*e.g.*, a bandwidth) or network-based events experienced by a mobile device (*e.g.*, scripted events). '192 Patent at 11:28-38, 12:3-20; '864 Patent at 11:7-17, 11:51-67; '678 Patent at 11:49-59, 12:26-42. One cannot visually "see" network conditions or network-based events. As such, a POSITA would not have understood what is meant by emulating or simulating a "network characteristic"

or an "operator network characteristic" "via" a display window, or what is meant by a "network characteristic" or an "operator network characteristic" being "visually" emulated or simulated. The "visually" instead refers to displaying certain information resulting from the claimed "simulate" or "emulate" operation.

53. In my opinion, a POSITA would have looked to FIGS. 8–13 and the accompanying disclosure to understand what the Asserted Patents mean by the "simulate/emulate, via one or more profile display windows" limitations because these limitations refer to the simulation or emulation of a "plurality of network characteristics" or a "plurality of operator network characteristics," and the Asserted Patents disclose that "[s]imulated network operation is described in further detail below and shown in FIGS. 8 though [*sic*] 13." '192 Patent at 10:23-25; '678 Patent at 10:42-44; '864 Patent at 10:1-3.[3]

54. In particular, the Asserted Patents describe the simulation or emulation of network characteristics in connection with a window that displays profile data in the following passage:

> Specifically, network simulator interface 804 within model 102 interacts with data provider 812 and event generator 814 to determine resource utilization resulting from network interaction by model 102. Thus, as application 104 plays within model 102, the effects of device 114 interacting with a wireless network are simulated such that frame based profile data display 110 shows resource utilization that includes the live or scripted effects of interaction with the wireless network. In one embodiment, capacity line 308 of display 300 within profile data display 110 is dynamically modified to show actual resource availability to application 104 resulting from resource utilization by simulated wireless network activity within device model 102. For example, if a message is received and/or retrieved by model 102 while playing application 104, certain resources are required to handle the received message, and therefore available resources for application 104 is reduced accordingly.

[3] Although FIGS. 8-13 only describe simulating network characteristics (not emulating network characteristics), to the extent that "emulate … a plurality of network characteristics" (as recited in claim 1 of the '192 Patent) is supported by the specifications of the Asserted Patents, that support would also be found in FIGS. 8-13 and its accompanying disclosure.

'192 Patent at 11:11-27; '678 Patent at 11:31-48; '864 Patent at 10:57-11:6. In this passage, the first sentence discloses that network simulator interface 804 (included within emulator 101) interacts with simulator 810 (*i.e.*, data provider 812 and event generator 814) to "determine resource utilization resulting from network interaction by model 102." The second sentence discloses that as "application 104 plays within model 102, the effects of device 114 interacting with a wireless network are simulated *such that frame based profile data display 110 shows resource utilization* that includes the live or scripted effects of interaction with the wireless network" (emphasis added). This second sentence thus discloses that profile data display 110, which the Asserted Patents describe as being displayed using display 300 ('192 Patent at 7:17-20, 8:39-41; '678 Patent at 7:32-36, 8:57-59; '864 Patent at 6:49-53, 8:4-6), shows "*resource utilization* that includes the live or scripted effects of interaction with the wireless network" (emphasis added). The third sentence further discloses the display of resource utilization, stating "capacity line 308 of display 300 within profile data display 110 is dynamically modified to show actual resource availability to application 104 resulting from resource utilization by simulated wireless network activity within device model 102." Thus, the displayed profile data shows the resources available to the application as a result of the imitated activity. The last sentence of the above-quoted passage sets forth an example of the simulation of a network characteristic: "a message is received and/or retrieved by model 102," which requires "certain resources … to handle the received message," and thus the "available resources for application 104 [are] reduced accordingly."

55. In addition, as I described in paragraph 46 above, the Asserted Patents disclose simulating (*i.e.*, imitating) a "network characteristic." *See also* '192 Patent at 12:3-20; '678 Patent at 12:26-42; '864 Patent at 11:51-67. A POSITA would have further understood that

emulating (*i.e.*, mimicking) a "network characteristic," given the '192 patent's use of the word "emulate" in this claim limitation, means that the network characteristic must be represented relatively more precisely than a simulation, *e.g.*, at an equivalent level of precision as the characteristics used to represent a mobile device, as set forth in Table 1 of the Asserted Patents.

56. I note for the Court that the "simulate/emulate, via one or more profile display windows" limitations recited in the '192 and '678 Patents further include the qualifier "simultaneously visually," whereas the recitations in the '864 Patent do not. But the specifications of the '192 and '678 Patents do not recite the word "simultaneously" nor do they recite the phrases "visually simulate" or "visually emulate." Nevertheless, the Asserted Patents describe at least two embodiments for how profile data (*i.e.*, resource data collected by the profile modules) is presented to the user. First, the Asserted Patents state that "[p]rofile data 152 may be displayed in real time as application 104 is played within model 102." '192 Patent at 8:31-32; '678 Patent at 8:49-51; '864 Patent at 7:64-65. Second, the Asserted Patents state that "[a]lternatively, profile data 152 may be output as a report (not shown)." '192 Patent at 8:34-35; '678 Patent at 8:53-54; '864 Patent at 7:67-8:1. In my opinion, a POSITA would understand that the "simultaneously visually" qualifier refers to the first embodiment I quoted, *i.e.*, an embodiment in which the profile data is displayed in real time at the same time as the simulation or emulation occurs. Conversely, the recitation of the "simulate/emulate, via one or more profile display windows" limitations in the '864 Patent, which does not include "simultaneously visually" qualifier, would encompass the second embodiment I described above, *i.e.*, an embodiment in which the resource information is made available for display.

I declare under penalty of perjury that the foregoing is true and correct. Executed this 19th day of February, 2019.

Matthew B. Shoemake, Ph.D.

Exhibit A

EXHIBIT A
LIST OF MATERIALS CONSIDERED

Asserted Patents

- U.S. Patent No. 8,924,192 ("the '192 Patent")
- U.S. Patent No. 9,298,864 ("the '864 Patent")
- U.S. Patent No. 9,971,678 ("the '678 Patent")
- Prosecution History of the '192 Patent
- Prosecution History of the '864 Patent
- Prosecution History of the '678 Patent

Extrinsic Evidence

- Microsoft Computer Dictionary (5th Ed. 2002) (DEF009155)
- Chambers Dictionary of Science and Technology (1999) (DEF009142)
- Wiley Electrical and Electronics Engineering Dictionary (2004) (DEF009176)
- Que's Computer User's Dictionary (1992) (DEF009168)
- The New IEEE Standard Dictionary of Electrical and Electronics Terms (5th Ed. 1993) (DEF009172)
- Comprehensive Dictionary of Electrical Engineering (2005) (DEF009146)
- IBM Dictionary of Computing (1994) (DEF009150)
- Newton's Telecom Dictionary (16th Ed. 2000) (DEF009160)
- Prentice Hall's Illustrated Dictionary of Computing (1992) (DEF009164)
- Modern Dictionary of Electronics (7th Ed. 1999) (as served by Plaintiffs with P.R. 4-2 disclosures)
- Merriam-Webster's Collegiate Dictionary (11th Ed. 2004) (as served by Plaintiffs with P.R. 4-2 disclosures)
- Microsoft Computer Dictionary (5th Ed. 2002) (as served by Plaintiffs with P.R. 4-2 disclosures)

Claim Construction Disclosures

- Defendant's P.R. 4-2 Disclosure, *Wapp Tech Limited Partnership and Wapp Tech Corp. v. Wells Fargo & Co.*, Case No. 4:18-cv-501-ALM
- Defendant's P.R. 4-2 Disclosure, *Wapp Tech Limited Partnership and Wapp Tech Corp. v. Bank of America Corp.*, Case No. 4:18-cv-519-ALM
- Defendants' P.R. 4-2 Disclosure, *Wapp Tech Limited Partnership and Wapp Tech Corp. v. Seattle Spinco, Inc. et al.*, Case No. 4:18-cv-469-ALM
- Plaintiffs' P.R. 4-2 Disclosures, *Wapp Tech Limited Partnership and Wapp Tech Corp. v. Seattle Spinco, Inc. et al.*, Case No. 4:18-cv-469-ALM
- Plaintiffs' P.R. 4-2 Disclosures, *Wapp Tech Limited Partnership and Wapp Tech Corp. v. Wells Fargo & Co.*, Case No. 4:18-cv-501-ALM
- Plaintiffs' P.R. 4-2 Disclosures, *Wapp Tech Limited Partnership and Wapp Tech Corp. v. Bank of America Corp.*, Case No. 4:18-cv-519-ALM

Miscellaneous

- Any other materials discussed or referenced in my declaration.

Exhibit B

Matthew B. Shoemake

Curriculum Vitae

Last updated February 19, 2020

Personal Information

Born **February 1971 in Pauls Valley, Oklahoma, USA**
Citizenship **United States of America**
Marital Status **Married to Bobbie Jo DeKay Shoemake since August 1998**
Children **One daughter, age 18, and one son, age 14**

Education

1999 **Ph.D. in Electrical Engineering**, *Cornell University*, Ithaca, New York.
1997 **M.S. in Electrical Engineering**, *Cornell University*, Ithaca, New York.
1994 **B.S. in Computer Science**, *Texas A&M University*, College Station, Texas, *with honors*.
1994 **B.S. in Electrical Engineering**, *Texas A&M University*, College Station, Texas, *with honors*.
1989 **Valedicatorian**, *Mexia High School*, Mexia, Texas.

Work Experience

2016–Present **Owner**, PERITUM LLC, Fairview, Texas.
- Peritum provides expert consulting services.
- Providing services since 2008. Incorporated in 2016.

2008–2018 **President & CEO**, BISCOTTI INC., Allen, Texas.
- Biscotti develops high-definition, video calling systems for the home and office.

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2003–2008 **President & CEO**, WiQuest Communications, Inc., Allen, Texas.
- Developed world's first 1 Gbps ultrawideband chipset
- Developed world's first wireless VGA/DVI system for notebook computers
- Customers put into product: Dell, Toshiba, Lenovo, Belkin, D-Link and Kensington
- Built company from inception to 120 employees with offices and personnel in Texas, India, California, Taiwan and Japan.

2000–2003 **Director Advanced Technology, Wireless Networking Business Unit**, Texas Instruments, Inc., Dallas, Texas.
- Lead development of Bluetooth and Wi-Fi coexistence technology
- Lead TI efforts to enhance the IEEE 802.11 standards with quality of service extensions
- Lead development of very low power Wi-Fi technology for mobile phones
- Designed Wi-Fi into Nokia Communicator

1998–2000 **Manager, Baseband Systems Team**, Alantro Communications, Inc., Dallas, Texas.
- Developed 802.11b compliant physical layer
- Shipped over 100M units in 2nd generation of IntelâĂŹs Centrino technology
- Company backed by Cisco and Vantage Point Venture Partners
- Acquired by Texas Instruments for $300MM

1991–1995 **Intern and Engineer, Digital Signal Processing Group**, Texas Instruments, Inc., Stafford, Texas.
- Product engineering for TMS320C2X Digital Signal Processors
- Applications engineering for TMS320C3X Digital Signal Processors

Ph.D. Dissertation

Title *Turbo Codes: Bounds and Applications, Ph.D., August 1999.*

Supervisor Professor Chris D. Heegard

Committee Members Professors Toby Berger, Chris D. Heegard, Dexter Kozen, Venugopal V. Veeravalli and Stephen Wicker

Masters Thesis

Title *Topics in Turbo Coding, M.S., May 1997.*

Supervisor Professor Chris D. Heegard

Fundraising

2010-2016 **$10M Series A**, Palomar Ventures, Biscotti Inc.

2009, 2016 **$1.35M Seed Investment**, Texas Emerging Technology Fund, Wham! Inc.

2008 **$50k Grant**, Allen Economic Development Center, Wham! Inc.

2008 **$420k Seed Round**, Private Individual Investors, Wham! Inc.

2007 **$5M Debt Line**, Triple Point Capital, for WiQuest Communications, Inc.

2007 **$23M Series C**, Lead by Adams Street Capital, WiQuest Communications, Inc.

2006 **$18M Series B**, Lead by Sequoia Capital, WiQuest Communications, Inc.

2005 **$50k Grant**, Allen Economic Development Center, WiQuest Communications, Inc.

2004 **$15M Series A**, Menlo Ventures, Palomar Ventures and iD Ventures America, WiQuest Communications, Inc.

2003 **$827k Seed Round**, Private Individual Investors, WiQuest Communications, Inc.

Computer Skills

Languages C, C++, Fortran, Python, Pascal, Java, Verilog, VHDL, BASIC, MATLAB, LaTeX, Spice, Perl, shell scripting, various assembly languages, Lisp.

Standards and Protocols IEEE 802.3, IEEE 802.11, DSL, DOCSIS, Bluetooth, I^2C, I^2S, USB, CAN bus, HDMI, LTE, IS-95, EDGE, LTO, RS-232, HTTP, FTP, Telnet, Internet Protocol (IP), TCP, UDP, RTP, RTCP, SIP, STUN, TURN, ICE, CSMA/CD, CSMA/CA, ITU-T J83B, IEEE 802.15, SSL, TLS, WEP, WPA, WPA2.

Professional Activities

2006-Present **External Advisory Committee, Texas A&M University, Department of Electrical and Computer Engineering**

2008-2010 **Board Member, TeXchange, Dallas Chapter** TeXchange is a non-for-profit organization dedicated to helping entrepreneurs succeed.

2003-2004 **Chairperson, IEEE 802.11n Task Group** Lead committee of over 300 engineers through initial stages of standardization of data rate enhancements in excess of 100 Mbps

Jan. 2002 **IEEE 802.11 Meeting Organizer and Host, Wyndham Anatole, Dallas, Texas**

2000-2003 **Chairperson, IEEE 802.11g Task Group** Lead committee of over 200 engineers to set standard for 54 Mbps data rates in the 2.4 GHz band in a fashion that is backward compatible with IEEE 802.11b. Standard become the basis for the most widely used version of Wi-Fi.

Sept. 1999 **IEEE 802.11 Meeting Organizer and Host, Hilton Sonoma County, Santa Rosa, California.**

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1999 **Chairperson, IEEE 802.11g Study Group**Lead committee of 20 engineers to set project requirements for IEEE 802.11g.

1991-Present **IEEE Member**

Awards

2012 **CES Innovation Award for the Biscotti TV Phone**

2008 **CES Innovation Award for Wireless Digital Video Technology** This high-speed digital video technology shipped in notebook computers from Toshiba.

2006 **Intel Technology Innovation Award** Awarded to WiQuest for innovations in Wireless USB technology.

2003 **PC Magazine Technology Excellence Award for IEEE 802.11g** This award was bestowed on the IEEE 802.11 Working Group and the Wi-Fi Alliance for the protocols incorporated in the IEEE 802.11g standard under my leadership.

2002 **Texas Instruments Senior Member Technical Staff**

1997-1998 **Intel Foundation Graduate Fellowship Award**

Consulting & Litigation Services

2020–Present ***Castlemorton Wireless, LLC v. Sprint Corporation, et al.*, (W.D. Tex.)**, Retained for Sprint via their counsel McGuireWoods LLP. Patent at issue is US 7,835,421. The accused products are alleged "to practice IEEE 802.11b and/or IEEE 802.11g" standards.

2019–Present ***Wapp Tech v. Micro Focus* (D. Del.)**, Retained for Micro Focus, et al. by Gibson Dunn. Patents at issue in case are US 8,924,192 and 9,971,678. Patents are directed to real-time system emulation on a mobile device.

2019 ***Blitzsafe v. Bosch* (N. D. Tex.)**, Retained by Bosch via their counsel DLA Piper. Patents asserted against the use of USB and Bluetooth in vehicles.

2019–Present ***Linksmart Wireless Technology LLC v. Panasonic Avionics Corp.* (C. D. Cali.)**, Retained by Panasonic Avionics via their counsel Haynes & Boone LLP. Case No. 8:18-cv-00662-AG-JDE (C. D. Cali.).

2019–Present ***Uniloc v. Blackberry* (N. D. Tex.)**, Retained by Blackberry via their counsel Baker Botts LLP. Case No. 3:18-cv-03068-N (N.D. Texas) Patents in-suit are US6,868,079, US6,993,049, US7,020,106 and US7,167,487.

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2019 ***Traxcell v. Sprint and Verizon* (E. D. Tex.)**, Retained by Sprint via their counsel McGuireWoods. Retained by Verizon via their counsel Holland & Knight LLP. Patents deal with network tuning, location determination and navigation. Patents at issue are US Patents 8,977,284, 9,510,320, 9,642,024 and 9,549,399. Wrote invalidity reports for Sprint and Verizon, and wrote a non-infringement report for Verizon. Depositions taken. No trial testimony, since cases settled shortly before trial due to granted summary judgement motions on non-infringement.

2019 ***Blitzsafe v. Daimler* (E. D. Tex.)**, Retained by Daimler via their counsel Quinn Emmanuel. Patents asserted against the use of USB and Bluetooth in vehicles.

2018–Present ***Sol IP v. Sprint* (E. D. Tex.)**, Retained by Sprint via their counsel McGuire-Woods. Sol IP, LLC v. Sprint Corporation, et al., Civil Action No. 2:18-cv-00527 (E.D. Tex.).

2018–2019 ***Parity Networks v. Hewlett Packard Enterprise Co.* (E. D. Tex.)**, Retained by HPE via their counsel Morgan Lewis. No reports, testimony nor depositions. HPE was dismissed from the case in March 2019 for unknown reasons.

2018–Present ***Uniloc v. AT&T* (E. D. Tex.)**, Retained by AT&T via their counsel Baker Botts LLP. Matter pertains to LTE License Assisted Access (LAA).

2018–2019 ***Bell North Research LLC v. Kyocera Corp.* (S. D. Cali.)**, Retained by Kyocera. via their counsel Jones Day. Bell Northern Research LLC v. Kyocera Corp. Case No. 3:18-cv-1785 (S.D. Cal.).

2018–2019 ***Koninklijke KPN N.V. v. Sierra Wireless, Inc., et al.* (D. Del.)**, Retained by Sierra Wireless Inc. via their counsel Kirkland & Ellis LLP. Matter involves ETSI and TIA licensing obligations. Expert report(s) submitted.

2018–2019 ***Hewlett Packard Enterprise Company v. ChriMar Systems, Inc.***, Retained by Hewlett Packard Enterprise Company via their counsel Morgan Lewis. Matter involves *inter partes* review of certain US Patents. Matter relates to power-over-ethernet (PoE). Patents owned by ChriMar Systems include 8,155,012, 8,942,107, 8,902,760, 9,019,838, 9,049,019, and 9,812,825.

2018–Present ***Hera Wireless and Sisvel v. Belkin Int'l. and ARRIS Group***, Retained by Belkin International and ARRIS Group via their counsel Duane Morris LLP. Case Nos. 1:17-cv-00948-RGA and 1:17-cv-00949-RGA.

2018–Present **Text Message and User Interfaces Services**, Retained by major mobile phone manufacturer in case related to text messaging and user interfaces.

2018–Dec 2019 ***Fundamental Innovation systems v. ZTE Corporation***, Retained in USB power case by ZTE via their counsel McDermott Will & Emory.

2018–2019 **Intel Corporation**, Retained via Intel's counsel, Kirkland & Ellis, in matter related to Wi-Fi in notebook computers.

2017–2019 **Intel Corporation**, Retained via Intel's counsel, Weil, Gotshal & Manges LLP. Matter relates to patents asserted against MIMO and/or beamforming in wireless OFDM communication systems.

2017–2018 ***PrefNet v. Sprint***, Working with Sprint's counsel, McGuireWoods. Case relates to management of bandwidth in network servers.

2017–2018 **Cisco Systems**, Working with Cisco's counsel, Kirkland & Ellis, on matter related to beamforming in Wi-Fi networks. No deposition nor trial testimony .

2017–2018 **Sharp Corporation**, Retained by Sharp's counsel, K&L Gates. Matter concerns intellectual property and Wi-Fi. No deposition nor trial testimony.

2017 **Harmon International Industries**, Retained by Harmon's counsel, McDermott, Will & Emory. Matter relates to car stereos and audio equipment in vehicles. No deposition nor trial testimony. .

2017-2018 **Wistron Corporation**, Retained by Wistron's counsel, JW Law Group. Matter relates to alleged Wi-Fi patents.

2017–2019 ***Blitzsafe v. Mitsubishi***, Retained via Mitsubishi Electric Corporation's counsel, Pillsbury, Winthrop, Shaw, Pittman LLP. Case relates to the use of Bluetooth and USB in vehicles. No deposition nor trial testimony.

2016–2017 ***Mtel v. Google***, Retained by Quinn Emanuel for Google. Case is a patent infringement case regarding US Patents 5,809,428, 5,894,506, 5,581,804 and 5,754,946. Case no. is 2:16-cv-00002 in E.D. Texas Marshall Division.

2016–2017 ***SPH America LLC v. Huawei Technology Co. Ltd.***, Retained by Foley and Lardner LLP for Huawei. Case no. is 13-cv-2323-CAB-KSC (S.D. Cal). No deposition nor trial testimony.

2016–2017 ***IV v. AT&T***, Retained by AT&T. AT&T's counsel is Baker Botts. Case is a patent infringement case related to DSL. No depositions nor trial testimony at this time.

2016–2019 ***Fujifilm v. Sony***, Retained on half of Fujifilm by their counsel Baker Botts. Cases relate to alleged standards and LTO data storage products. The matters are being heard in the ITC and in an associated district court case. Deposition and trial testimony.

2016–2017 ***Blitzsafe v. Honda***, Retained via Honda's counsel, Jones Day. Case relates patent infringement and use of Bluetooth and USB in vehicles. Deposition take. No trial testimony.

2016 ***Network-1 vs. Dell Inc.***, Retained via Dell's counsel K&L Gates in a patent litigation related to power over Ethernet. No depositions nor trial testimony.

2016–Present ***California Institute of Technology (Caltech) vs. Broadcom Corporation and Apple Inc.***, Retained via Caltech's counsel, Quinn Emanuel. Case relates to use of forward error correction in Wi-Fi products. Technology tutorial presented to district court. Expert reports submitted. Testimony provide to court at various hearings. Testified on infringement and technical value of patents at trial in January 2020. Was sole expert witness for Caltech. Jury found Apple and Broadcom infringe and awarded $1.1B in damages.

2015–2016 **California Institute of Technology (Caltech)**, Analysis of IEEE 802.11 patents. No depositions nor trial testimony.

2015–2016 **Wistron Corporation**, Retained to analyze certain communication system patents in the LTE space. No depositions nor trial testimony.

2015–2016 **Wistron Corporation**, Retained via Wistron's counsel, K&L Gates, to perform analysis related to Wi-Fi. No depositions nor trial testimony.

2015–2016 ***LSI v. Funai***, Retained by Baker & Hostetler to provide services in connection with LSI Corp. et al. v. Funai Electric Co. Ltd. Case relates OFDM patent asserted against Wi-Fi products. No deposition nor trial testimony.

2015–2016 ***Mtel v. Blackberry***, Retained by Blackberry via their counsel McDermott Will & Emery LLP. Patent case related to pagers. Patents asserted against mobile phones. Deposition taken. No trial testimony.

2015 ***Ericsson v. Apple***, Retained by Apple via their counsel Fish & Richardson. Patent case related to Wi-Fi and cellular. Deposition and trial testimony in ITC case..

2015 ***Antennatech LLC v. Mercedes-Benz USA LLC***, Retained by Mercedes-Benz via their counsel Quinn Emanuel Urquhart & Sullivan, LLP. Patent case related to Wi-Fi inside vehicles. No deposition nor trial testimony..

2015 **Samsung**, Retained via Williams & Connolly LLP on behalf of their their client Samsung. Case relates to cross license between two parties, including access by Samsung to Nokia's Wi-Fi patent portfolio. No deposition nor trial testimony.

2015 ***Cablevision v. Verizon***, Retained via Kirkland & Ellis on behalf of their client Verizon. Matter relates to false advertising claims tied to use of IEEE 802.11ac routers. No deposition. Testified at trial.

2014 **Blitz Stream Video LLC**, Retained as consultant related to portfolio of video patents. No deposition nor trial testimony.

2014-2016 ***SPH America v. Blackberry Limited***, Retained by Blackberry via their counsel Quinn Emanuel Urquhart & Sullivan, LLP. No deposition nor trial testimony.

2014-2015 ***CSIRO v. MediaTek***, Nokia, Texas Instruments, Realtek and Barnes & Noble via a joint defense group including Covington & Burling LLP. Serving both as expert for JDG and 30(b)(6) witness for Texas Instruments. No trial testimony.

2014-2018 ***ChriMar v. Cisco***, Retained by Cisco via their counsel Kirkland & Ellis. Matter relates to power over Ethernet. Deposition. No trial testimony.

2014-2016 ***Intellectual Ventures v. CenturyLink, et al.***, Retained by CenturyLink via their counsel O'Melveny & Myers LLP. No deposition nor trial testimony.

2013-2015 ***Intellectual Ventures v. Canon Inc., et al.***, Retained by Canon Inc, et al. via their counsel Quinn Emanuel Urquhart & Sullivan, LLP. Deposition. No trial testimony.

2013-2017 ***Intellectual Ventures v. AT&T Mobility LLC, et al.***, Retained by Sprint Spectrum LP via their counsel McGuireWoods LLP. Case relates to security in IEEE 802.11 networks. No deposition nor trial testimony.

2014 ***NXP v. Blackberry***, Services retained by Blackberry via their counsel McDermott Will & Emery. No deposition. Testified at trial..

2013-2014 ***Realtek Semiconductor Corp v. LSI Corporation et al.***, Retained by Realtek Semiconductor Corp via their counsel ReedSmith. Deposition and trial testimony.

2013-2017 ***CSIRO v. Cisco System Inc.***, Retained by Cisco via their counsel Duane Morris. Deposition and trial testimony..

2013 ***Cisco Systems, Inc. and Motorola Solutions, Inc. v. Innovatio IP Ventures LLC***, Retained by Kirkland and Ellis on behalf of Cisco Systems, Motorola Solutions, Inc. and NETGEAR. Deposition and trial testimony.

2013 ***Wi-LAN v. HTC, et al.***, Retained HTC Corporation, HTC America Inc., and Exedea, Inc. via their counsel Sheppard Mullin Richter & Hampton, Novatel via their counsel K&L Gates, and Sierra Wireless via their counsel Nixon Peabody. Expert reports also filed on behalf of other defendants including Apple and Alcatel Lucent. Deposition. Case settled prior to trial.

2012-2013 ***Ericsson, et al. v. D-Link, et al.***, Retained via Intel via their counsel Kirkland & Ellis. Deposition and trial testimony.

2011-2013 ***Mosaid Technologies Incorporated v. Dell, Inc. et al.***, Retained by Intel via their counsel WilmerHale, and retained by Marvell via their counsel Quinn Emanuel Urquhart & Sullivan, LLP. No deposition. Case settled prior to trial..

2011-2012 ***Broadcom Corporation and Atheros Communications, Inc. vs. Commonwealth Scientific and Industrial Research Organization.***, Retained by Broadcom via Potter Minton. Deposition. Case settled prior to trial.

2010-2011 ***Wi-LAN vs. RIM, PCD, LG, Motorola, LG, et al.***, Was an expert witness for the defense. Retained by PCD and a major Korean cell phone manufacturer. PCD distributes phones made by HTC. Deposition. No trial testimony.

2009-2011 ***Wi-LAN vs. Acer, Intel, Broadcom, Atheros, Marvell, et al.***, Was expert witness for defense. Focused specifically on US Patent 5,282,222 related to OFDM technology. Served as expert related to wireless, the IEEE standards process and provided testimony related to damages. Retained by Intel, Broadcom and Marvell. Desposition. Case settled on the eve of trial.

2008-2009 ***CSIRO vs. Intel, Broadcom, Microsoft, HP, Dell, D-Link, et al.***, Served as fact witness related to 802.11 standardization, rules, process and events related to the formation of the 802.11 standard. Testified at trial.

Articles

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Books

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Conferences and Standard Meetings

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Recent Talks

8 March 2019 Texas A&M University Department of Electrical & Computer Engineering, Distinguished Speaker Series for Leaders & Innovators. Talk on LDPC error correction coding in the IEEE 802.11 standard.

21 July 2019 Duke University TIP program. Talk on the history of security in IEEE 802.11 with focus on cryptological errors made in WEP.

Community Service

27 Feb 2019 Southern Methodist University judge of business plans for entrepreneurship course.

2019-Present Official Scorekeeper for D-Bat Elite 13U Majors Boys Baseball Team

2016-2018 Official Scorekeeper for NTX Eagles 10U-12U Majors Boys Baseball Team

2017 Head Coach of Patriots 12U Boys Competitive Basketball in Allen Sports Association.

2013-2015 Head and Assistant Coaching Positions for 8U-9U Boys Competitive Baseball in Allen Sports Association.

2009 Advocated and Succeeded in Moving Entire Grade of Elementary School Children from Temporary to Permanent Facilities.

2008 Advocated and Established After School Science Program at Local Elementary School.

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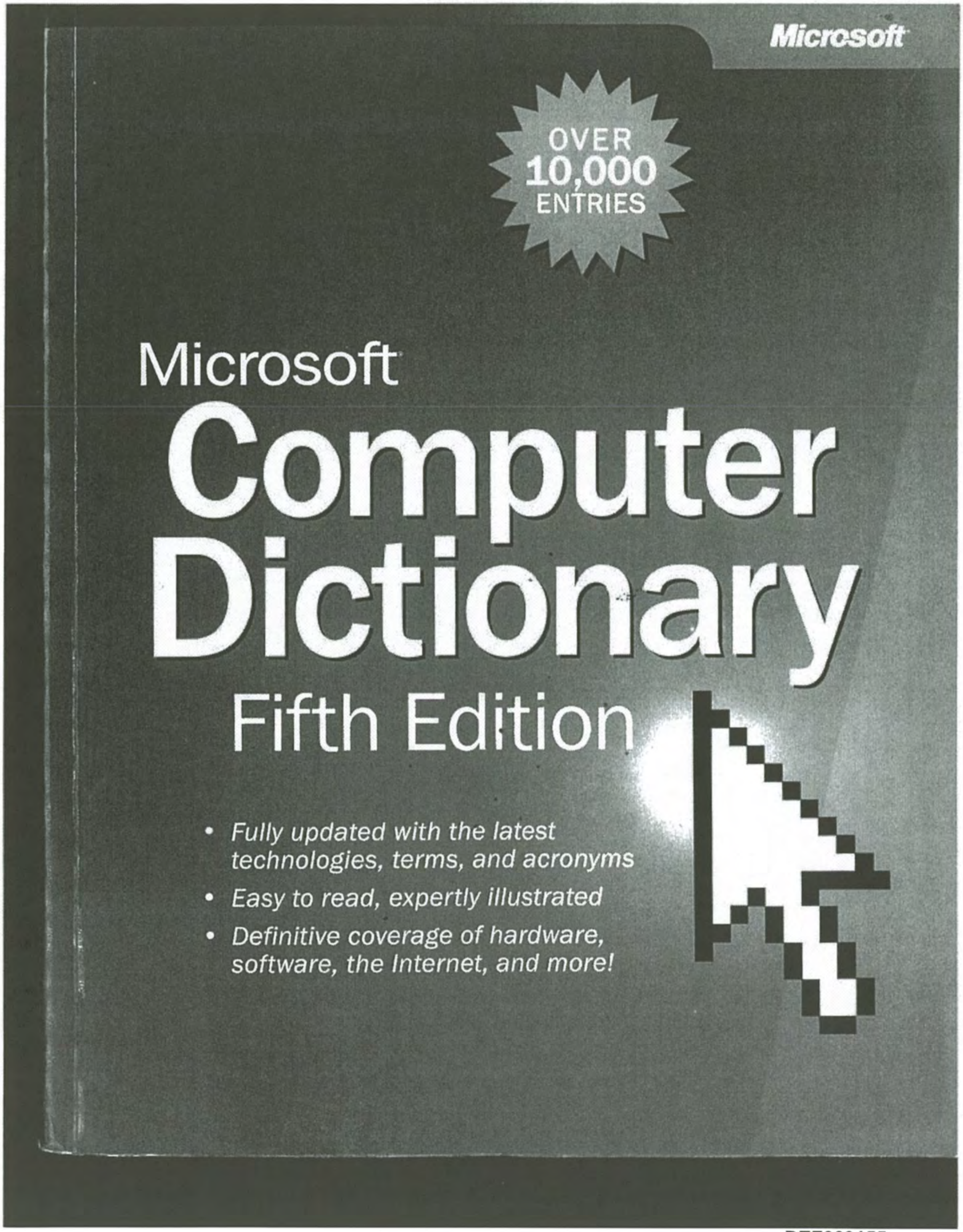
Exhibit C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within a larger device or system. An embedded system is often built onto a single chip or board and is used to control or monitor the host device—usually with little or no human intervention and often in real time. *See also* microprocessor.

em dash *n.* A punctuation mark (—) used to indicate a break or interruption in a sentence. It is named for the em, a typographical unit of measure that in some fonts equals the width of a capital M. *Compare* en dash, hyphen.

EMF *n. See* electromotive force.

emitter *n.* In transistors, the region that serves as a source of charge carriers. *Compare* base (definition 3), collector.

emitter-coupled logic *n.* A circuit design in which the emitters of two transistors are connected to a resistor so that only one of the transistors switches at a time. The advantage of this design is very high switching speed. Its drawbacks are the high number of components required and susceptibility to noise. *Acronym:* ECL.

EMM *n. See* Expanded Memory Manager.

e-money or **emoney** *n.* Short for electronic **money**. A generic name for the exchange of money through the Internet. *Also called:* cybercash, digicash, digital cash, e-cash, e-currency.

emotag *n.* In an e-mail message or newsgroup article, a letter, word, or phrase that is encased in angle brackets and that, like an emoticon, indicates the attitude the writer takes toward what he or she has written. Often emotags have opening and closing tags, similar to HTML tags, that enclose a phrase or one or more sentences. For example: <joke>You didn't think there would really be a joke here, did you?</joke>. Some emotags consist of a single tag, such as <grin>. *See also* emoticon, HTML.

emoticon *n.* A string of text characters that, when viewed sideways, form a face expressing a particular emotion. An emoticon is often used in an e-mail message or newsgroup post as a comment on the text that precedes it. Common emoticons include :-) or :) (meaning "I'm smiling at the joke here"), ;-) ("I'm winking and grinning at the joke here"), :-(("I'm sad about this"), :-7 ("I'm speaking with tongue in cheek"), :D or :-D (big smile; "I'm overjoyed"), and :-O (either a yawn of boredom or a mouth open in amazement). *Compare* emotag.

EMS *n.* Acronym for Expanded Memory Specification. A technique for adding memory to PCs that allows for increasing memory beyond the Intel 80x86 microprocessor real-mode limit of 1 megabyte (MB). In earlier versions of microprocessors, EMS bypassed this memory board limit with a number of 16-kilobyte banks of RAM that could be accessed by software. In later versions of Intel microprocessors, including the 80386 and 80486 models, EMS is converted from extended memory by software memory managers, such as EMM386 in MS-DOS 5. Now EMS is used mainly for older MS-DOS applications because Windows and other applications running in protected mode on 80386 and higher microprocessors are free of the 1-MB limit. *Also called:* LIM EMS. *See also* expanded memory, protected mode. *Compare* conventional memory, extended memory.

em space *n.* A typographical unit of measure that is equal in width to the point size of a particular font. For many fonts, this is equal to the width of a capital M, from which the em space takes its name. *Compare* en space, fixed space, thin space.

emulate *vb.* For a hardware or software system to behave in the same manner as another hardware or software system. In a network, for example, microcomputers might emulate terminals in order to communicate with mainframes.

emulation *n.* The process of a computer, device, or program imitating the function of another computer, device, or program.

emulator *n.* Hardware or software designed to make one type of computer or component act as if it were another. By means of an emulator, a computer can run software written for another machine. In a network, microcomputers might emulate terminals in order to communicate with mainframes.

emulsion laser storage *n.* A method for recording data in film by selective heating with a laser beam.

enable *vb.* To activate or turn on. *Compare* disable.

encapsulate *vb.* **1.** To treat a collection of structured information as a whole without affecting or taking notice of its internal structure. In communications, a message or packet constructed according to one protocol, such as a TCP/IP packet, may be taken with its formatting data as an undifferentiated stream of bits that is then broken up and packaged according to a lower-level protocol (for example, as ATM packets) to be sent over a particular network; at the destination, the lower-level packets are assembled, re-creating the message as formatted for the encapsulated protocol. *See also* ATM (definition 1). **2.** In object-oriented

E

nications. The addition of SBC's Internet customer base made Prodigy the third largest ISP in the United States.

Prodigy Information Service *n.* An online information service founded by IBM and Sears. Like its competitors America Online and CompuServe, Prodigy offers access to databases and file libraries, online chat, special interest groups, e-mail, and Internet connectivity. *Also called:* Prodigy.

product *n.* **1.** An operator in the relational algebra used in database management that, when applied to two existing relations (tables), results in the creation of a new table containing all possible ordered concatenations (combinations) of tuples (rows) from the first relation with tuples from the second. The number of rows in the resulting relation is the product of the number of rows in the two source relations. *Also called:* Cartesian product. *Compare* inner join. **2.** In mathematics, the result of multiplying two or more numbers. **3.** In the most general sense, an entity conceived and developed for the purpose of competing in a commercial market. Although computers are products, the term is more commonly applied to software, peripherals, and accessories in the computing arena.

production system *n.* In expert systems, an approach to problem solving based on an "IF this, THEN that" approach that uses a set of rules, a database of information, and a "rule interpreter" to match premises with facts and form a conclusion. Production systems are also known as rule-based systems or inference systems. *See also* expert system.

P

Professional Graphics Adapter *n.* A video adapter introduced by IBM, primarily for CAD applications. The Professional Graphics Adapter is capable of displaying 256 colors, with a horizontal resolution of 640 pixels and a vertical resolution of 480 pixels. *Acronym:* PGA.

Professional Graphics Display *n.* An analog display introduced by IBM, intended for use with their Professional Graphics Adapter. *See also* Professional Graphics Adapter.

profile¹ *n. See* user profile.

profile² *vb.* To analyze a program to determine how much time is spent in different parts of the program during execution.

profiler *n.* A diagnostic tool for analyzing the run-time behavior of programs.

Profiles for Open Systems Internetworking Technology *n. See* POSIT.

program¹ *n.* A sequence of instructions that can be executed by a computer. The term can refer to the original source code or to the executable (machine language) version. *Also called:* software. *See also* program creation, routine, statement.

program² *vb.* To create a computer program, a set of instructions that a computer or other device executes to perform a series of actions or a particular type of work.

program button *n.* On a handheld device, a navigation control that is pressed to launch an application. *Also called:* application button.

program card *n. See* PC Card, ROM card.

program cartridge *n. See* ROM cartridge.

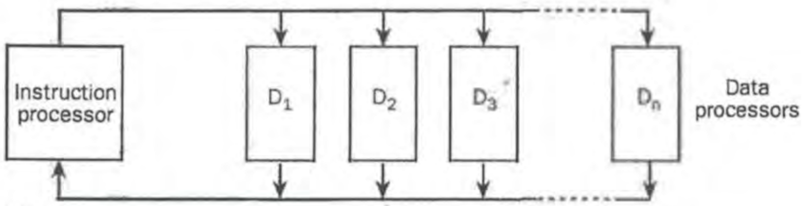
program comprehension tool *n.* A software engineering tool that facilitates the process of understanding the structure and/or functionality of computer applications. *Acronym:* PCT. *Also called:* software exploration tool.

program counter *n.* A register (small, high-speed memory circuit within a microprocessor) that contains the address (location) of the instruction to be executed next in the program sequence.

program creation *n.* The process of producing an executable file. Traditionally, program creation comprises three steps: (1) compiling the high-level source code into assembly language source code; (2) assembling the assembly language source code into machine-code object files; and (3) linking the machine-code object files with various data files, run-time files, and library files into an executable file. Some compilers go directly from high-level source to machine-code object, and some integrated development environments compress all three steps into a single command. *See also* assembler, compiler (definition 2), linker, program.

program encapsulation *n.* A method of dealing with programs with Year 2000 problems that entailed modifying the data with which a program worked. The input data is modified to reflect a parallel date in the past that the program can handle. When output is generated, that data is changed again, to reflect the correct date. The program itself remains unchanged.

program file *n.* A disk file that contains the executable portions of a computer program. Depending on its size and



SIMD.

SIMM *n.* Acronym for single inline memory module. A small circuit board designed to accommodate surface-mount memory chips.

Simple API for XML *n. See* SAX.

Simple Authentication and Security Layer *n. See* SASL.

Simple Control Protocol *n. See* SCP.

Simple Mail Transfer Protocol *n.* A TCP/IP protocol for sending messages from one computer to another on a network. This protocol is used on the Internet to route e-mail. *Acronym:* SMTP. *See also* communications protocol, TCP/IP. *Compare* CCITT X series, Post Office Protocol.

Simple Network Management Protocol *n. See* SNMP.

Simple Object Access Protocol *n. See* SOAP.

simplex *n.* Communication that takes place only from sender to receiver. *Compare* duplex[2] (definition 1), half-duplex[2].

simplex transmission *n. See* simplex.

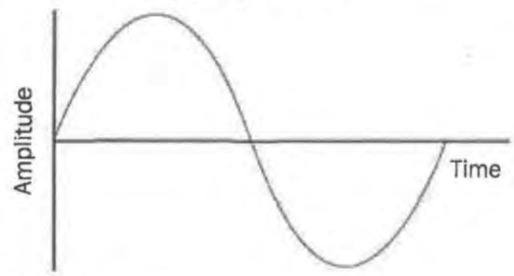
SIMULA *n.* Short for **simula**tion **la**nguage. A general-purpose programming language based on ALGOL 60, with special features designed to aid the description and simulation of active processes. Visual C++ is based on aspects of this language.

simulation *n.* The imitation of a physical process or an object by a program that causes a computer to respond mathematically to data and changing conditions as though it were the process or object itself. *See also* emulator, modeling (definition 1).

simultaneous access *n. See* parallel access.

simultaneous processing *n.* **1.** True multiple-processor operation in which more than one task can be processed at a time. *See also* multiprocessing, parallel processing. **2.** Loosely, concurrent operation in which more than one task is processed by dividing processor time among the tasks. *See also* concurrent, multitasking.

sine wave *n.* A uniform, periodic wave often generated by an object that vibrates at a single frequency. See the illustration. *Compare* square wave.



Sine wave.

single attachment station *n.* An FDDI node that connects to the primary ring through a concentrator. *Compare* dual attachment station.

single-board *adj.* Of or pertaining to a computer that occupies only one circuit board, usually with no capacity for additional boards.

single-density *adj.* Of or pertaining to a disk that is certified only for use with frequency modulation (FM) recording. A single-density disk can store much less data than a disk using modified FM encoding or run-length limited encoding. *See also* modified frequency modulation encoding, run-length limited encoding.

Single Image Random Dot Stereogram *n. See* autostereogram.

Single Image Stereograms *n. See* autostereogram.

single inline memory module *n. See* SIMM.

single inline package *n. See* SIP.

single inline pinned package *n. See* SIP.

single-instruction, multiple-data stream processing *n. See* SIMD.

single-line digital subscriber line *n. See* SDSL.

single-precision *adj.* Of or pertaining to a floating-point number having the least precision among two or more

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Exhibit D

CHAMBERS

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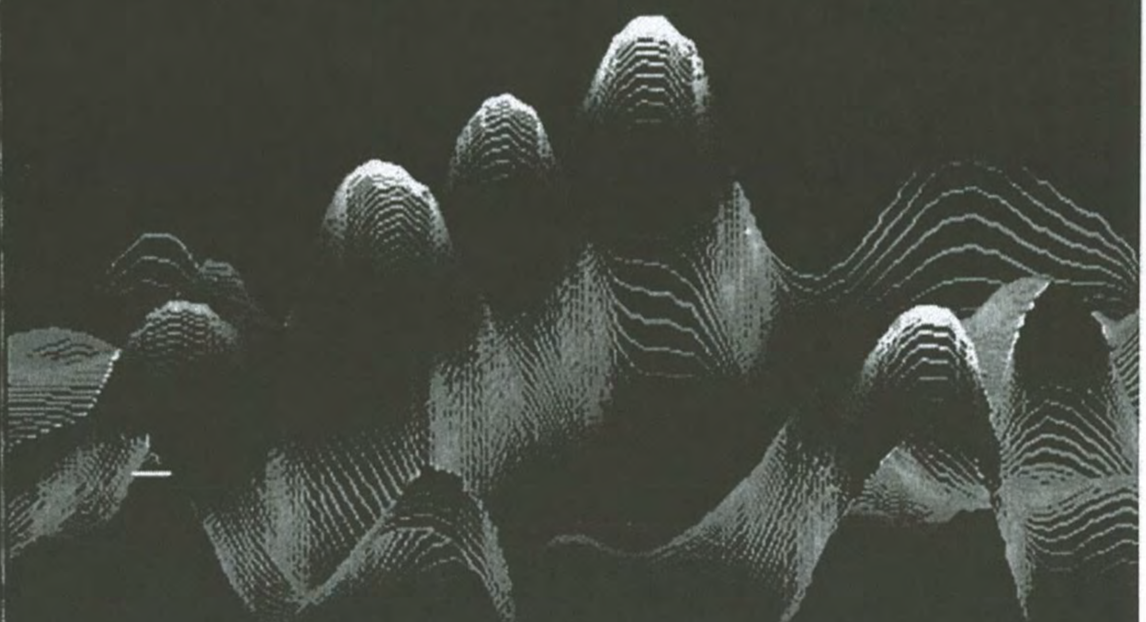

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emissive power (*Phys*) The energy radiated at all wavelengths per unit area per unit time from a surface. It depends on the nature of the surface and on its temperature. See **emissivity, emission.**

emissivity (*Phys*) The ratio of emissive power of a surface at a given temperature to that of a black body at the same temperature and with the same surroundings. Values range from 1·0 for lampblack down to 0·02 for polished silver. See **Stefan–Boltzmann law.**

emitter (*Electronics*) In a transistor, the region from which charge carriers, that are minority carriers in the base, are injected into the base.

emitter follower (*Electronics*) See **common-collector connection.**

emitter junction (*Electronics*) One biased in the low resistance direction, so as to inject minority carriers into the base region.

emmetropia (*Med*) The normal condition of the refractive system of the eye, in which parallel rays of light come to a focus on the retina, the eyes being at rest. Adj *emmetropic.*

empennage (*Aero*) See **tail unit.**

emphasizer (*Telecomm*) An audio-frequency circuit which selects and amplifies specific frequencies or frequency bands.

emphysema (*Med*) (1) The presence of air in the connective tissues. (2) The formation in the lung of bullae or spaces containing air, as a result of destruction of alveoli and rupture of weakened alveolar walls.

emphysematous chest (*Med*) The barrel-shaped, immobile chest which is the result of chronic bronchitis and emphysema.

empirical formula (*Chem*) Formula deduced from the results of analysis which is merely the simplest expression of the ratio of the atoms in a substance. In molecular materials it may, or may not, show how many atoms of each element the molecule contains: eg methanal, CH_2O, ethanoic acid, $C_2H_4O_2$, and lactic acid, $C_3H_6O_3$, have the same percentage composition, and consequently, on analysis, they would all be found to have the same empirical formula.

empirical formula (*Genrl*) A relationship founded on experience or experimental data only, not deduced in form from purely theoretical considerations.

empiricism (*Genrl*) The regular scientific procedure whereby scientific laws are induced by inductive reasoning from relevant observations. Critical phenomena are deduced from such laws for experimental observation, as a check on the assumptions or hypotheses inherent in the theory correlating such laws. Scientific procedure, described by empiricism, is not complete without the experimental checking of deductions from theory.

emplastrum (*Med*) A medicated plaster for external application.

emplectum (*Build*) An ancient form of masonry, showing a squared stone face, sometimes interrupted by courses of tiles at intervals.

empress (*Build*) A slate size, 26 × 16 in (660 × 406 mm).

emprosthotonos (*Med*) Bending of the body forwards caused by spasm of the abdominal muscles, as in tetanus.

empty band (*Phys*) See **energy band.**

empty set (*Maths*) The set denoted by φ or { } which has no elements.

empyema (*Med*) Accumulation of pus in any cavity of the body, esp the pleural cavity.

em quad (*Print*) A square quadrat of any size of type. Less than type height, it is used for spacing. Usually called a 'mutton' to distinguish it clearly from an en (or nut quad).

em rule (*Print*) The dash (—). A thin horizontal line one em of the type body in width. Apart from its uses as a mark of punctuation, it is often used to build up rules in tabular work. Also *em score, metal rule, mutton rule.*

EMS (*Comp*) Abbrev for **expanded memory** specification.

Emsian (*Geol*) A stage in the Lower Devonian. See **Palaeozoic.**

emulation (*Comp*) A mode in which a device may emulate the operational characteristics of another device, eg one printer may behave like another type of printer.

emulator (*Comp*) A program which causes one **computer** to behave as if were another type of computer; eg a computer may emulate an IBM-compatible one.

emulsification (*Print*) A fault found in lithographic printing whereby fine droplets of water become dispersed in the ink on the press rollers during printing.

emulsified coolant (*Eng*) These are used as cutting media in (metal) machining. The three main types are: (1) an emulsion of water, a thick soap solution and a mineral oil, (2) an emulsion of a mineral oil and soft soap or some other alkaline soap solution, and (3) an emulsion of a sulphurized or sulphonated oil neutralized and blended with a soluble oil.

emulsifier (*Chem*) An apparatus with a rotating, stirring or other device used for making emulsions.

emulsifying agent (*Chem*) A substance whose presence in small quantities stabilizes an emulsion, eg ammonium linoleate, certain benzene-sulphonic acids etc.

emulsion (*Chem*) A colloidal suspension of one liquid in another, eg milk. See panel on **Gels.**

emulsion (*FoodSci*) A colloid in which the dispersed and continuous phases are two immiscible liquids. Emulsions can be oil in water eg mayonnaise or water in oil eg margarine. Since they tend to be unstable, an emulsifying agent to stabilize the droplets in the disperse phase is needed.

emulsion (*ImageTech*) A suspension of finely divided silver halide crystals in a medium such as gelatine which provides the light-sensitive coating on film, glass plates and paper and plastic supports. It may also contain sensitizing dyes and colour-forming **couplers.**

emulsion paint (*Build*) A water-thinnable paint made from a pigmented emulsion or dispersion of a resin (generally synthetic) in water. The resin may be polyvinyl acetate, polyvinyl chloride, an acrylic resin or the like.

emulsion polymerization (*Chem*) See **chain polymerization** and panel on **Polymer synthesis.**

emulsion technique (*Phys*) A method used to study sub-atomic particles by means of tracks formed in photographic emulsion.

emunctory (*Med*) Conveying waste matter from the body; any organ or canal which does this.

en (*Chem*) Abbrev for *1,2-diamino ethane, ethylene diamine,* $(CH_2NH_2)_2$, in complexes.

en (*Print*) A unit of measurement used in reckoning up composition. It is assumed that the average letter has the width of one en and that the average word, including the space following, has the width of six ens. See **en quad.**

enabling pulse (*Electronics*) One which opens a **gate** which is normally closed.

enamel (*ElecEng*) General term for hard surface coatings, eg oil-based paints containing resin and used for wire insulation and in building.

enamel (*Glass*) Surface coating of opaque glass fused onto metal articles for decoration or to provide a hard, inert and impermeable layer on eg cooking vessels. Also *vitreous enamel.* See **frit.**

enamel (*Zool*) The hard external layer of a tooth consisting almost entirely of large elongated apatite (calcium phosphate) crystals set vertically on the surface of the underlying dentine; enamel also occurs in certain scales.

enamel cell (*Zool*) See **ameloblast.**

enamel-insulated wire (*ElecEng*) Wire having an insulating covering of **enamel** used for winding small magnet coils etc.

enamelled brick (*Build*) A brick having a glazed surface.

simple group (*Maths*) A group which has no normal subgroups except for the identity and the group itself.

simple harmonic motion (*Phys*) The motion of a particle (or system) for which the force on the particle is proportional to its distance from a fixed point and is directed towards the fixed point. The particle executes an oscillatory motion about the point. The motion satisfies the equation $(d_2x/dt_2) = -\omega^2 x$ where x is the displacement of the particle and ω is a constant for the motion. The majority of small amplitude oscillatory motions are simple harmonic, eg the oscillations of a mass suspended by a spring, the swing of a pendulum, the vibrations of a violin string, the oscillations of atoms or molecules in a solid, or the oscillations of air as a sound wave passes. When such a motion takes place in a resistive medium, eg air, the oscillations die away with time; the motion is then said to be *damped*. Abbrev *shm*.

simple leaf (*Bot*) A leaf in which the lamina consists of one piece, which, if lobed, is not cut into separate parts reaching down to the midrib.

simple network management protocol (*Comp*) A protocol used for managing **networks**, especially **TCP/IP**.

simple pit (*Bot*) A pit of which the cavity does not become markedly narrower towards the cell lumen. Cf **bordered pit**.

simple press tool (*Eng*) **Press tool** which performs only one operation at each stroke of the press, as distinct from a **compound press tool** and a **progressive press tool**.

simple sequence DNA (*Biol*) Block of a DNA sequence which consists of many repeats of a short, unit sequence. The repeats are not necessarily identical.

simple steam engine (*Eng*) An engine with one or more cylinders in which the steam expands from the initial pressure to the exhaust pressure in a single stage. Cf **compound steam engine**.

simplex (*Comp*) Transmission of data in only one direction.

simplex (*Telecomm*) Method of working in which messages are only ever carried in one direction over a given channel.

simplex winding (*ElecEng*) An armature winding through which there is only one electrical path per pole.

simply connected domain (*Maths*) See **connected domain**.

Simpson's rule (*Maths*) The area under the curve $y=f(x)$ from $x=x_0$ to $x=x_2$ is approximately $\frac{1}{3}[f(x_0)+4f(x_1)+f(x_2)][x_2-x_0]$, where x_0, x_1 and x_2 are equally spaced.

SIMS (*Phys*) Abbrev for **secondary ion mass spectrometry**.

Sims' speculum (*Med*) A speculum, shaped like a duck's bill, for viewing the lining of the vagina and the cervix uteri.

simulated line (*Telecomm*) See **artificial line**.

simulation (*Comp, Electronics*) The representation of physical systems and phenomena by computers, models and other equipment.

simulation (*Zool*) Mimicry; assumption of the external characters of another species in order to facilitate the capture of prey or escape from enemies. v. *simulate*.

simulation by computer (*Behav*) The investigation of thought processes by the use of computers programmed to imitate them.

simulcasting (*Telecomm*) Inelegant abbrev for **simultaneous broadcasting**.

simultaneity (*Phys*) A basic consequence of **special relativity**. Two events that are simultaneous according to one observer may occur at different times according to another observer in another reference frame moving relative to the first.

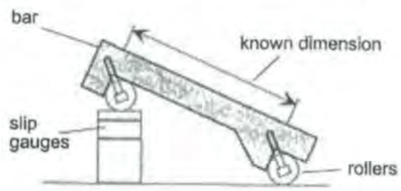
simultaneous broadcasting (*Telecomm*) (1) Transmission of one programme from two or more transmitters. (2) Simultaneous television and radio (usually stereophonic) broadcasts from live concerts etc. Latter also *simulcasting*.

sin (*Maths*) See **trigonometrical functions**.

Sindanyo (*ElecEng*) TN designating materials, composed principally of asbestos, for the mounting of switchgear of all types for electrical insulation work generally, and for arc shields, barriers, furnace linings and other purposes.

sine (*Maths*) See **trigonometrical functions**.

sine bar (*Eng*) A hardened steel bar carrying two rollers of standard diameter accurately spaced to some standard distance; used with **slip gauges** to set out angles to close limits.



sine bar Bar and rollers are precision ground.

sine condition (*Phys*) A condition which must be satisfied by a lens if it is to form an image free from aberrations (other than chromatic). It may be stated $n_1 l_1 \sin\alpha_1 = n_2 l_2 \sin\alpha_2$, where n_1 and n_2 are the refractive indices of the media on the object and image sides of the lens respectively, l_1 and l_2 are the linear dimensions of the object and image, and α_1 and α_2 are the angles made with the principal axis by the conjugate portions of a ray passing between object and image.

sine galvanometer (*ElecEng*) A galvanometer in which the coil and scale are rotated to keep the needle at zero. The current is then proportional to the sine of the angle of rotation. The arrangement can be made more sensitive than the **tangent galvanometer**.

Sinemurian (*Geol*) A stage in the Lower Jurassic. See **Mesozoic**.

sine potentiometer (*ElecEng*) Voltage divider in which the output of an applied direct voltage is proportional to the sine of the angular displacement of a shaft.

sine wave (*Phys*) Waveform of a single frequency, indefinitely repeated in time, the only waveform whose integral and differential has the same waveform as itself. Its displacement can be expressed as the sine (or cosine) of a linear function of time or distance, or both. In practice there must be a transient at the start and finish of such a wave.

singing (*Telecomm*) Oscillation in a telephone system caused by feedback across a source of gain because of mismatch in the circuit.

singing tube (*Acous*) (1) A tube with a flame inside which under certain conditions excites the tube resonance. (2) See **Rijke tube**.

single-acting cylinder (*Eng*) Fluid-powered cylinder in which the piston is displaced in one direction by the fluid and returned mechanically, usually by a spring.

single-acting engine (*Eng*) A reciprocating engine in which the working fluid acts on one side of the piston only, as in most IC engines.

single bridging (*Build*) Bridging in which a pair of diagonal braces are used to connect adjacent floor-joists at their middle points.

single-catenary suspension (*ElecEng*) A catenary suspension system in which the conductor wire is hung from a single catenary or bearer wire.

single-cell protein (*Bot*) Protein-rich material from cultured algae, fungi (including yeasts) or bacteria, used (potentially) for food or as animal feed. Abbrev *SCP*.

single-channel per carrier (*Telecomm*) Used in satellite communications for a system where each carrier is dedicated to one telephone call or data transmission for its duration. Cf **time-division multiple access**.

single-channel pulse height analyser (*Telecomm*) See **pulse height analyser**.

single-core cable (*ElecEng*) A cable having only one conductor.

single crystal (*Crystal*) Crystal formed by propagation of unit cell in three dimensions, usually from a single nucleus. Common in many minerals but absent in polycrystalline metals and ceramics. Massive single crystals of silicon

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are normal. See
Polymer synth

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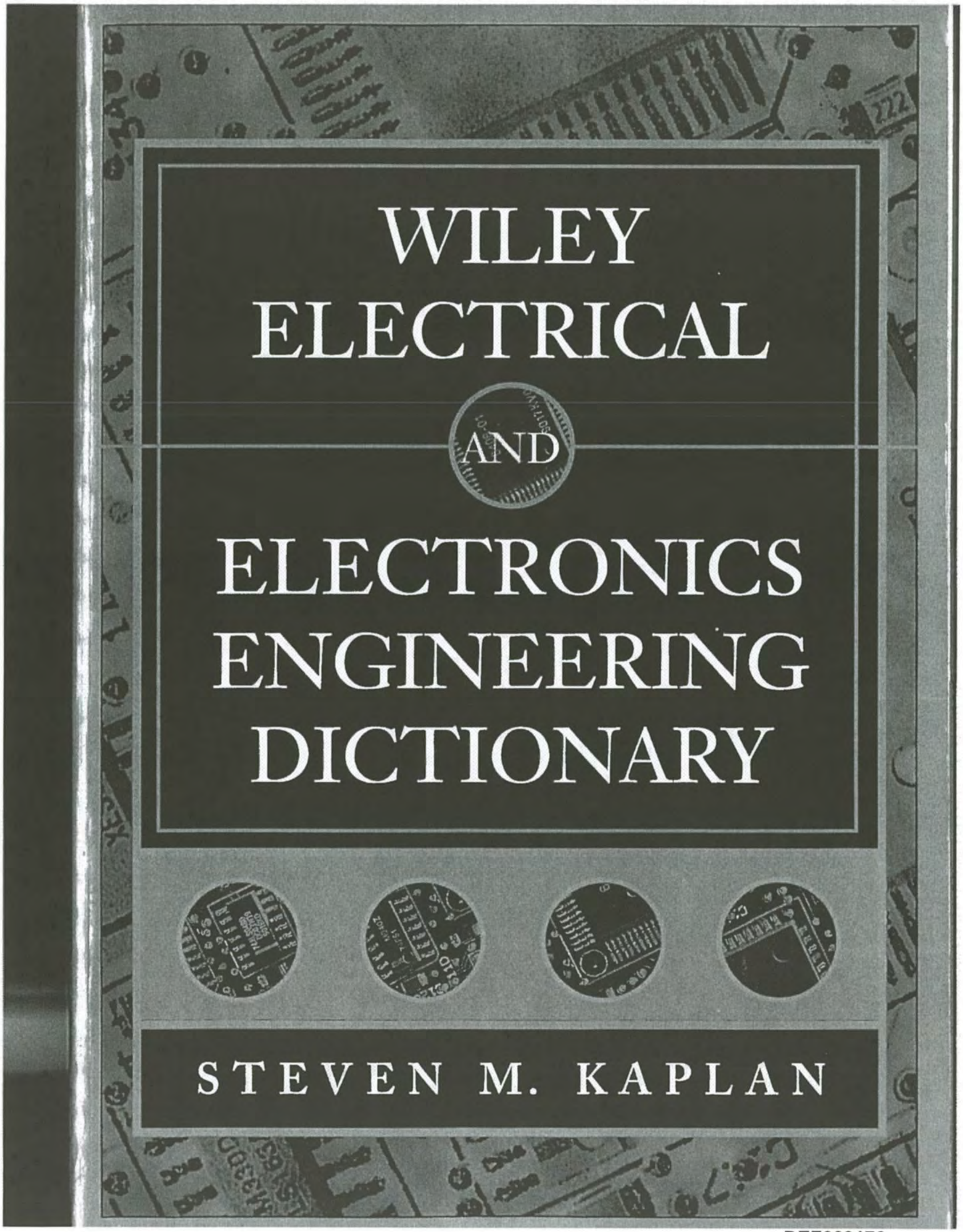
Exhibit E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emphasizer 1. An electric network which serves to provide **emphasis (1)**. 2. An electric network which serves to provide **emphasis (2)**. Also called **preemphasis network**.

empiric Same as **empirical**.

empirical Based on, or depending upon observation, experience, or experimentation, as opposed to theory. Also spelled **empiric**.

empty band 1. A band which is not in use. 2. A band which is not occupied. 3. An energy band which is not occupied by any electrons.

EMR Abbreviation of **electron magnetic resonance**.

EMS 1. Abbreviation of **electromagnetic susceptibility**. 2. Abbreviation of **Expanded Memory Specification**. 3. Abbreviation of **event-management system**.

emu Abbreviation of **electromagnetic system of units**.

emulation 1. The use of an **emulator**. 2. The function of an **emulator**.

emulation mode A hardware and/or software operation mode in which another device and/or software is being emulated. For instance, a printer which emulates another printer, so as to be compatible with existing software.

emulator Computer hardware and/or software which is designed to work exactly like another. Seen, for instance, in printer emulation, so that a printer made by one manufacturer is able to work with the software intended for a printer of a different manufacturer. Another example is the design of a computer to run on software intended for another.

EMV Abbreviation of **electromagnetic vulnerability**. Same as **electromagnetic susceptibility**.

enable To turn on, or to put into operation. May refer to a component, device, circuit, piece of equipment, function, program, or system.

enable pulse An pulse that turns on, puts into operation, or prepares for a subsequent action. May refer to a component, circuit, device, piece of equipment, function, program, or system.

enabled Turned on, or operating. May refer to a component, circuit, device, piece of equipment, function, program, or system.

enamel A glass-like coating utilized to provide a hard and/or glossy finish. May be used, for instance, for insulation and/or corrosion protection.

enameled wire Wire which has a baked-on enamel film, which provides insulation. May be used, for instance, in coils.

encapsulant That which serves to **encapsulate (2)**. For instance, a wax, a plastic, or a ceramic.

encapsulate 1. To embed or incorporate into something else. 2. To encase or embed in a surrounding mass or enclosure which houses and protects. For instance, an electronic component may be encapsulated in plastic, to insulate and protect from moisture. Such a plastic would usually be in a molten state when applied to the component, then let solidify for a snug fit.

Encapsulated PostScript A file format for importing and exporting Postscript files. Its abbreviation is **EPS**.

encapsulation 1. The process of applying an **encapsulant**. May be accomplished, for example, by dipping a component or device in molten glass, then letting cool. 2. In object-oriented programming, the hiding of the implementation details of an object. The services the object provides are defined and accessible, but their internal workings are not. Also called **information hiding (2)**. 3. A technique which enables a network to send data utilizing one protocol, through another network using different protocol. It does so by encapsulating packets using one network protocol within packets being transmitted through the other network. Also called **tunneling (2)**.

encipher Same as **encode (2)**.

enclosure 1. That which serves to house something else. For instance, a cabinet which holds an apparatus. 2. A cabinet designed to house one or more speaker units. Two common designs are acoustic reflex and acoustic suspension. Within a speaker system, a specialized speaker such as a woofer or tweeter may have its own enclosure, helping enhance performance. Also called **speaker enclosure**, or **loudspeaker enclosure**. 3. Same as **email attachment**.

encode 1. To express information utilizing a code. 2. To scramble information, such as data, in a manner which only those with a key can decipher. Usually used for security purposes. Also called **encrypt**, **encipher**, **code (4)**, or **scramble (1)**. 3. To write a set of computer instructions.

encoded Also called **coded**. 1. Information, such as data, which is in the form of a code. Also called **encrypted (1)**. 2. Information, such as data, which has been scrambled in some manner. Also called **encrypted (2)**. 3. Programs or program instructions which have been written.

encoded data Data which has been **encoded**. May be used, for instance, where privacy or security is a concern. Also called **coded data**, or **scrambled data**.

encoded signal A signal which has been **encoded**. May be used, for instance, where privacy or security is a concern. Also called **coded signal**, or **scrambled signal**.

encoded speech Speech which has been **encoded (2)**, so that it can only be understood with a receiver with the proper circuits and settings. May be used, for instance, where eavesdropping is a concern. Also called **coded speech**, or **scrambled speech**.

encoder 1. A circuit, device, piece of equipment, program, system, or method utilized to **encode**. For instance, computer hardware and/or software used for such a purpose. 2. In a TV transmitter, a circuit or device which transforms the separate red, green, and blue camera signals into color-difference signals, and combines these with the chrominance subcarrier. Also called **color encoder**, or **matrix (3)**. 3. An electromechanical device, such as a shaft-position encoder, which converts the rotations of a shaft into pulses. 4. A device which converts an analog quantity into a digital signal. 5. A device or piece of equipment which prints characters in a certain font and places them in specific locations, so as to facilitate being read by optical character recognition devices.

encoding That processes performed by an **encoder**.

encrypt Same as **encode (2)**.

encrypted 1. Same as **encoded (1)**. 2. Same as **encoded (2)**.

encryption The coding of information so that only the intended recipients can understand it. It is an extremely efficient method to achieve data security, and a code, or key, is used to convert the information back to its original form. Public-key encryption and secret-key encryption are the two most common types.

encryption algorithm A set of mathematic formulas utilized to scramble information, such as data, in a manner which only those with a key can decipher.

encryption key A series of binary digits or characters that are incorporated into data to encrypt it.

end bell 1. In a rotating motor, the part of the housing which supports the bearing and guards the rotating parts. Also called **end bracket**, or **end shield**. 2. A cable clamp which is affixed to the back of a plug or receptacle.

end bracket Same as **end bell (1)**.

end cell In a storage battery, a cell which may be connected with the others, so as to adjust the overall voltage.

end device Same as **end instrument**.

end effect In an antenna, an effect due to capacitance at the ends of the radiators. Capacitive coupling with the sur-

simulation 1. An imitation, model, or other representation of an object, situation, process, feature, manner of operation, or the like. Such a simulation is intended to faithfully reproduce the real or theoretical objects, situations, processes, and so on, it is based on, and can be used, for instance, for analysis, testing, or training. 2. The use of a computer to imitate an object or process. Sophisticated software, combined with accurate input devices, enable a computer to respond mathematically to factors such as changing conditions, as if it were the object or process itself. Such simulations may be used to represent or emulate almost anything, including weather conditions or biological processes, and may be utilized to test new theories. Also called **computer simulation**. 3. A mathematical model which is utilized to represent a physical component, circuit, device, piece of equipment, system, process, or phenomenon. 4. The use of software and/or hardware which enables programs written for one computer to work properly with another system. 5. The use of software and/or hardware which enables programs written for one computer to work properly with another system which would have otherwise been incompatible.

Simulation Program with Integrated Circuit Emphasis Software utilized to simulate or model ICs at the transistor level. Its abbreviation is **SPICE**.

simulator 1. A device, computer, apparatus, enclosure, location, or the like which is utilized to prepare and/or experience simulations. 2. Software and/or hardware which enables programs written for one computer to work properly with another system. 3. Software and/or hardware which enables programs written for one computer to work properly with another system which would have otherwise been incompatible.

simulcast 1. The simultaneous broadcasting of the same program over two different transmission systems. For example, an AM and an FM station transmitting the same program at the same time, or the concurrent transmission of DTV content along with regular TV content. 2. The simultaneous broadcasting of the same program over two or more stations utilizing the same transmission system. For example, the same TV content presented at the same time over multiple networks.

simultaneous 1. Occurring, performed, or existing at the same instant. 2. Occurring, performed, or existing concurrently. 3. Pertaining to that which is **simultaneous (1)**, or **simultaneous (2)**.

simultaneous access Also called **parallel access**. 1. Storage and/or retrieval of data to or from a computer storage medium in which multiple bits, characters, or data units are transferred simultaneously. This contrasts with **serial access (1)**, where bits, characters, or data units are transferred sequentially. Also called **simultaneous storage**. 2. Reading and/or writing of data from or to computer memory in which multiple bits, characters, or data units are transferred simultaneously. This contrasts with **serial access (2)**, where bits, characters, or data units are transferred sequentially.

simultaneous processing Also called **parallel processing**, **multiprocessing**, or **concurrent execution (2)**. 1. The simultaneous execution of multiple computer operations by multiple CPUs in a single computer. Such processors are usually linked by high-speed channels. 2. The simultaneous execution of multiple computer operations by a single computer, whether it utilizes multiple processors or another mechanism. 3. The utilization of multiple computers to perform multiple operations simultaneously.

simultaneous processors Two or more processors utilized for **simultaneous processing**. These processors may be located in a single computer, or in multiple computers. Also called **parallel processors**.

simultaneous storage Same as **simultaneous access (1)**.

simultaneous transmission 1. The simultaneous emission or transmission of multiple signals, waves, or messages, to more than one recipient or location. 2. Simultaneous transmission by two or more locations or nodes in both directions at the same time, as occurs in duplex transmission.

simultaneous voice and data A technology, such as DSVD, which enables voice and data signals to be transmitted simultaneously over a single analog telephone line. Such signals may or may not be compressed. Its abbreviation is **SVD**.

SINAD Abbreviation of **signal-to-noise-and distortion ratio**.

SINAD ratio Abbreviation of **signal-to-noise-and distortion ratio**.

sine For a right triangle, the ratio of the length of the side opposite to an acute angle, to the length of the hypotenuse. This contrasts with **cosine**, which is the ratio of the length of the side adjacent to an acute angle, to the length of the hypotenuse.

sine curve The graph obtained from the following equation: $y = \sin x$. Such a curve proceeds smoothly from 0 to 1 to 0 to −1 to 0 to 1 and so on. Also called **sinusoid**.

sine law A law which states that the intensity of radiation from a linear source is proportional to the sine of the angle formed between the axis of said source and the specific direction being considered.

sine wave A periodic wave whose amplitude follows the values of a sine curve. Simple harmonic motion is a sinusoidal function of time. Power mains current without harmonic current has this waveform. Also called **sinusoidal wave**.

sine-wave frequency response A measure of the behavior of a component, circuit, device, piece of equipment, or system, as a function of its input signal frequencies. For example, it may refer to the efficiency of the amplification of a circuit or device as a function of frequency. Also known as **sine-wave response**, **frequency response (1)**, or **amplitude-frequency response**.

sine-wave response Same as **sine-wave frequency response**.

sine waveform The shape of a **sine wave**.

singing An unwanted self-sustained oscillation, usually resulting from excessive feedback. It may be manifested, for instance, as a continued whistle or howl in an amplified telephone circuit.

single-address instruction In computer programming, an instruction which contains one address part. Also called **one-address instruction**.

single-attachment station Within a dual-ring FDDI network, a node which a connection to one of the rings, usually the primary ring. Its abbreviation is **SAS**.

single-balanced mixer A mixer circuit which suppresses one of its inputs, usually that of the local oscillator. Balance may be achieved, for instance, utilizing a ring configuration of diodes. Used, for example, in superheterodyne receivers. Also called **balanced mixer**.

single-board Pertaining to a **single-board computer**.

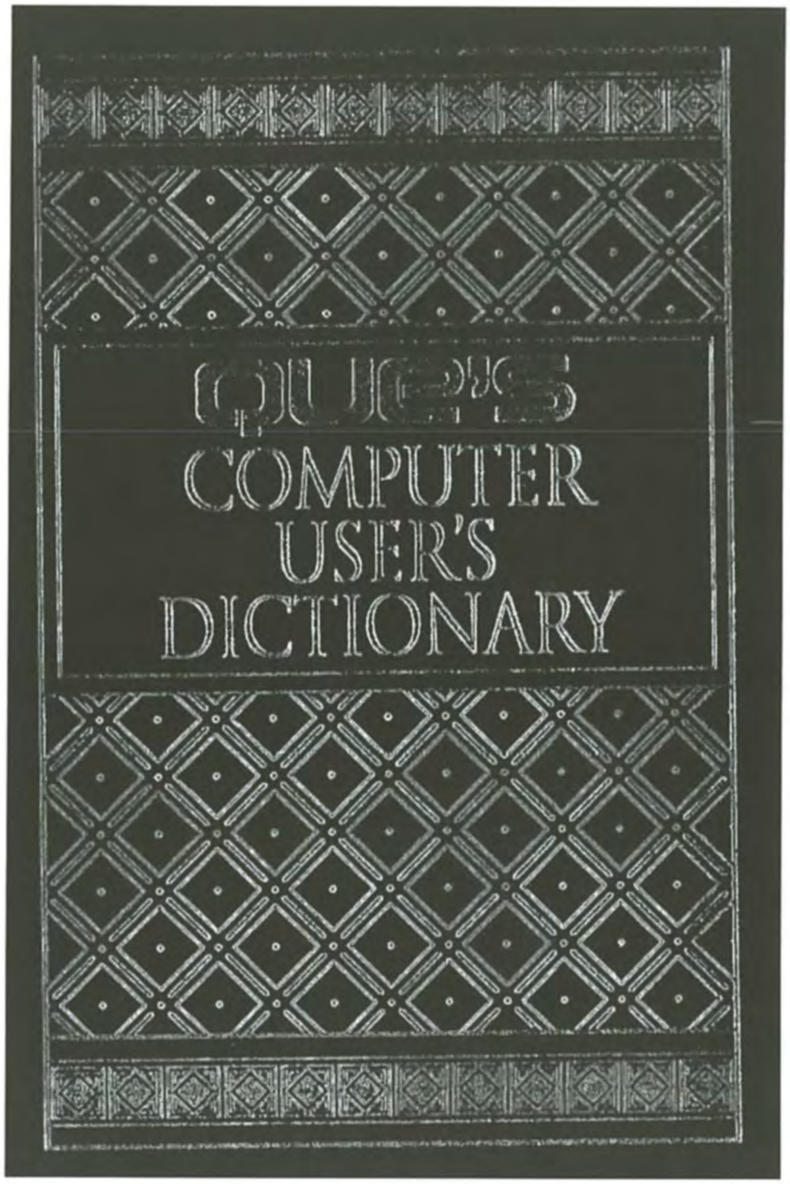
single-board computer A complete computer contained on a single printed-circuit board. Such a board must have a CPU, memory, a clock, and input/output circuits. Its abbreviation is **SBC**.

single-chip module A package which houses a single chip, as opposed to a **multichip module**, which houses multiple interconnected chips on a common substrate. Its abbreviation is **SCM**.

Single Connector Attachment Same as **SCA**.

single-crystal Pertaining to, or consisting of, a **single-crystal structure** or **single-crystal material**.

Exhibit F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DICTIONARY

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Acknowledgments

The language of personal computing is changing as fast as the technology, and that's why Que is publishing a second edition of *Computer User's Dictionary*. In this edition, you find expanded coverage of memory management, Microsoft Windows, desktop publishing, and other exciting, new areas of personal computing hardware and applications.

In keeping with personal computing's close contact with users and Que's dedication to readers, we have responded to the many reader suggestions for new terms to include. I would like to thank all who wrote to us. Very special thanks are due to Thomas Oleszczuk, Ph.D., of the U.S. Merchant Marine Academy, who combed through the entire book, page by page, and wrote a detailed commentary; and Robert de Violini, Editor of the *Channel Islands PC Users' Group* newsletter, who also made many useful suggestions.

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Que gave me the freedom to attempt a totally new kind of dictionary, a user's dictionary: it's a dictionary written from the personal computer user's viewpoint. Terms are included only if they're relevant to personal computer user—and they're defined with the user's needs in mind. Academic types and lexicographers may find this approach wrong-headed or even to pose a danger to Civilization for having ob-

desktop publishing techniques. Many programs include outline and shadow characters that should be used only rarely. See *type style*.

EMS See *Lotus-Intel-Microsoft Expanded Memory Specification (LIM EMS)*.

emulation The duplication of the functional capability of one device in another device.

In telecommunications, for example, a personal computer emulates a dumb terminal for on-line communication with a distant computer. See *terminal*.

en A unit of measurement in typesetting that equals half the width of an em space, the width of the capital letter M in the current typeface.

en dash A continuous dash equal in width to one half em, the width of the capital letter M in the current typeface.

En dashes are used in place of the English words to or through, as in pp. 63–68 or January 9–14. See *em dash*.

en fraction A single-character fraction that occupies one en of space and uses a horizontal stroke. See *em fraction*.

Encapsulated PostScript (EPS) file A high-resolution graphic image stored using instructions written in the PostScript page description language.

The EPS standard enables the device-independent transfer of high-resolution graphic images between applications. EPS graphics are of outstanding quality and can contain subtle gradations in shading, high-resolution text with special effects, and graceful curves generated by mathematical equations.

The printout resolution is determined by the printing device's maximum capabilities; on laser printers, EPS graphics print at 300 dpi, but on Linotronic typesetters, resolutions of up to 2540 dpi are possible. EPS images can be sized without sacrificing image quality.

lation exists between the paragraphs in one column and the paragraphs in another; on the contrary, they may move freely and independently of one another.

Because the paragraphs in a side-by-side format often are of unequal length, you cannot align them with tabs. The best word processing programs, such as WordPerfect and Microsoft Word, include commands that set up side-by-side columns and display the format on-screen as you type and edit. See *newspaper columns*.

SideKick A popular desktop accessory for IBM Personal Computers and compatibles and the Macintosh developed by Borland International. The program includes an address book, an appointment calendar, a notepad, a calculator, and other utilities.

SIG See *special interest group (SIG)*.

signal The portion of a transmission that coherently represents information, unlike the random and meaningless noise that occurs in the transmission channel.

silicon chip See *chip*.

Silicon Valley An area in California's Santa Clara Valley with one of the largest concentrations of high-technology businesses in the world.

SIMM See *single in-line memory module (SIMM)*.

simple list text chart In presentation graphics, a text chart used to enumerate items in no particular order and with each item given equal emphasis. See *presentation graphics*.

simulation An analytical technique used in computer applications, in which a phenomenon's properties are investigated by creating a model of the phenomenon and exploring the model's behavior.

One of the most important contributions the computer is making

lies in its provision of new, useful tools for simulation. In aeronautical engineering, for example, the aerodynamic properties of a proposed aircraft could be simulated only through the time-consuming and expensive construction of a series of physical models, which were subjected to wind-tunnel tests.

Now, however, you can design and test thousands of alternative models in short order by using computer simulation techniques. The wind tunnel, therefore, is becoming an anachronism in modern aerospace firms.

In education, simulation techniques are enabling schools that cannot afford laboratory equipment to offer students a chance to engage in simulated, on-screen versions of classic laboratory experiments.

Simulation also is found in computer games, such as Microsoft Flight Simulator. This program is so realistic in its simulation of powered flight that it has been used as a prelude to professional flight instruction in many flight schools.

Users of spreadsheet programs frequently use simulation techniques to create a model of a business. Using simulation, a manager can ask what-if questions such as, "What is the effect on market share if we expend an additional 20 percent on advertising?"

As with any model, however, a simulation is only as good as its underlying assumptions. If these assumptions are not correct, the model does not accurately mimic the behavior of the real-world system being simulated.

single density The earliest magnetic recording scheme for digital data used a technique called frequency modulation (FM) that resulted in low information densities (such as 90K per disk).

Disk drives designed for FM recording, therefore, could use disks (single-density disks) with relatively large-grained magnetic particles. Single-density recording disks have been superseded by double-density storage devices that use modified frequency modulation (MFM) storage techniques, double-density disks with finer

Exhibit G

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angle, per unit bandwidth) radiated by a material body to the power radiated by a black body at the same temperature. 211-1990

emittance (1) ε **(illuminating engineering).** The ratio of radiance in a given direction (for directional emittance) or radiant exitance (for hemispherical emittance) of a sample of a thermal radiator to that of a blackbody radiator at the same temperature. Formerly, exitance. The use of exitance with this meaning is deprecated. [126]
(2) (photovoltaic power system). The ratio of the radiant flux-intensity from a given body to that of a black body at the same temperature. *See:* **photovoltaic power system; solar cells (photovoltaic power system).** [41]

emitter (transistor). A region from which charge carriers that are minority carriers in the base are injected into the base. 216-1960w, 270-1966w, [12]

emitter, majority (transistor). An electrode from which a flow of majority carriers enters the interelectrode region. *See:* **transistor.** [12]

emitter, minority (transistor). An electrode from which a flow of minority carriers enters the interelectrode region. *See:* **semiconductor; transistor.** [119]

emitting sole (microwave tubes). An electron source in crossed-field amplifiers that is extensive and parallel to the slow-wave circuit and that may be a hot or cold electron-emitter. *See:* **microwave tube or valve.** [45]

EMP. *See:* **electromagnetic pulse.** 211-1990

empirical. Pertaining to information that is derived from observation, experiment, or experience. 610.3-1989

empirical propagation model (electromagnetic compatibility). A propagation model that is based solely on measured path-loss data. *See:* **electromagnetic compatibility.** [53]

empty medium. A data medium that does not contain data. 610.5-1990

empty queued arbitrated (QA) slot. A queued arbitrated (QA) slot that was designated by the head of bus function as being available for transfer of a QA segment, and that does not contain a QA segment. 802.6-1990

EMT (cable system in power generating stations). Electrical metallic tubing. 166-1977

emulate. To represent a system by a model that accepts the same inputs and produces the same outputs as the system represented. For example, to emulate an 8-bit computer with a 32-bit computer. *See also:* **simulate.** 610.3-1989

emulation (software). (A) A model that accepts the same inputs and produces the same outputs as a given system. *See also:* **simulation.**
(B) The process of developing or using a model as in (A). 610.3-1989, 610.12-1990

emulator (modeling and simulation) (software). A device, computer program, or system that performs emulation. 610.3-1989, 610.12-1990

enable (supervisory control, data acquisition, and automatic control) (station control and data acquisition). A command or condition which permits some specific event to proceed. C37.1-1987

enabling pulse (1) (navigation). A pulse that prepares a circuit for some subsequent action. 686-1982, [42]
(2). A pulse that opens an electric gate normally closed, or otherwise permits an operation for which it is a necessary but not a sufficient condition. *See:* **pulse.** [119]

enamel (1) (general). A paint that is characterized by an ability to form an especially smooth film. [9], [65]
(2) (wire) (rotating machinery). A smooth film applied to wire usually by a coating process. *See:* **rotor (rotating machinery); stator.** [9]

encapsulated (rotating machinery). A machine in which one or more of the windings is completely encased by molded insulation. *See:* **asynchronous machine.** [9]

encapsulation (1) (of a semiconductor radiation detector) (germanium gamma-ray detectors). The packaging of a detector for protective or mounting purposes, or both. 325-1986
(2) (software). A software development technique that consists of isolating a system function or a set of data and operations on those data within a module and providing precise specifications for the module. *See also:* **data abstraction; information hiding.** 610.12-1990

enclosed (NESC). Surrounded by case, cage, or fence designed to protect the contained equipment and minimize the possibility under normal conditions of dangerous approach or accidental contact by persons or objects. C2-1984

enclosed brake (industrial control). A brake that is provided with an enclosure that covers the entire brake, including the brake actuator, the brake shoes, and the brake wheel. *See:* **electric drive.** [60], [75]

enclosed capacitor (shunt power capacitors). A capacitor having enclosed terminals. The enclosure is provided with means for connection to a rigid or flexible conduit. 18-1980

enclosed cutout (power switchgear). A cutout in which the fuse clips and fuseholder or disconnecting blade are mounted completely within an insulating enclosure. C37.40-1981, C37.100-1981

simulate (1) (computing systems). To represent the functioning of one system by another, for example, to represent one computer by another, to represent a physical system by the execution of a computer program, to represent a biological system by a mathematical model. *See:* **electronic analog computer.** [20], [85]
(2) (modeling and simulation). To represent a system by a model that behaves or operates like the system. *See also:* **emulate.** 610.3-1989

simulated fly ash. The entrained ash produced by suspension firing in a small-scale pulverized coal combustor designed and operated with the objective of closely approximating certain selected properties of the fly ash produced in the full-scale steam generator of interest. The combustor should have the capability of providing approximately the same time/ temperature profile for combustion as would occur in a full-scale boiler furnace. This process is applicable particularly when coal from a new source has never been burned in a full-scale boiler. 548-1984

simulated meter. A simulated meter is an assembly consisting of a watthour meter cover, base, and jumper bars constructed to represent the thermal characteristics of a specific class of watthour meter to be used in the testing of a meter socket for temperature rise at continuous ampere rating. C12.10-1987

simulated source (sodium iodide detector). A radioactive source consisting of one or more long-lived radionuclides that are chosen to simulate the radiations from a short-lived radionuclide of interest. N42.12-1980

simulated sources ("dose calibrator" ionization chambers) (ionization chambers). Simulated sources usually contain long-lived radionuclides, alone or in combination, that are chosen to simulate, in terms of photon or particle emission, a short-lived radionuclide of interest. N42.13-1986

simulated time. Time as represented within a simulation. *Syn:* **virtual time.** *See also:* **fast time; real time; slow time.** 610.3-1989

simulation (1) (analog computers). The representation of an actual or proposed system by the analogous characteristics of some device easier to construct, modify, or understand. 165-1977
(2) (modeling and simulation) (software). (A) A model that behaves or operates like a given system when provided a set of controlled inputs. *Syn:* **simulation model.** *See also:* **emulation.** (B) The process of developing or using a model as in (A). 610.3-1989, 610.12-1990
(3) (computer applications). An instruction method employed by some computer-assisted instruction systems, in which a situation is simulated and the student must respond appropriately. *Contrast with:* **instructional game; question-and-answer interaction.** 610.2-1987
(4) (mathematical). The use of a model of mathematical equations generally solved by computers to represent an actual or proposed system. 165-1977

simulation clock. A counter used to accumulate simulated time. 610.3-1989

simulation game. A simulation in which the participants seek to achieve some agreed-upon objective within an established set of rules. For example, a management game, a war game. *Note:* The objective may not be to compete, but to evaluate the participants, increase their knowledge concerning the simulated scenario, or achieve other goals. *Syn:* **gaming simulation.** 610.3-1989

simulation language. A programming language used to implement simulations. 610.3-1989

simulation model. *See:* **simulation.** 610.3-1989

simulator (1) (analog computers). A device used to represent the behavior of a physical system by virtue of its analogous characteristics. In this general sense, all computers are, or can be, simulators. However in a more restricted definition, a simulator is a device used to interact with, or to train, a human operator in the performance of a given task or tasks. 165-1977
(2) (modeling and simulation) (software). A device, computer program, or system that performs simulation. *See also:* **emulator.** 610.3-1989, 610.12-1990
(3) (test, measurement, and diagnostic equipment). A device or program used for test purposes that simulates a desired system or condition providing proper inputs and terminations for the equipment under test. [2]

simultaneous. Pertaining to the occurrence of two or more events at the same instant of time. *Contrast with:* **concurrent.** 610.12-1990

simultaneous access. *See:* **immediate access.** 610.5-1990

simultaneous line downtime. *See:* **partial system downtime.** 973-1990

simultaneous lobing (1) (electronic navigation). A direction-determining technique utilizing the received energy of two concurrent and partially overlapped signal lobes: the relative phase, or the relative power, of the two signals received from a target is a measure of the angular displacement of the target from the equiphase or equisignal direction. Compare with lobe switching. 149-1979, [35], [42]
(2) (radar) (antennas). A direction-determining technique utilizing the signals of overlapping lobes existing at the same time. *Syn:* **(radar) monopulse.** 686-1982, 145-1983

simultaneous recursion (software). A situation in which two software modules call each other. 610.12-1990

SINA
SINA ter dis exp plu rec car res sig au au
sina me (1) no a sig sys
sina mi inp rat pe
sine sta eq fre of of mo of us su dif wi the be be pa (2) eq sta fre of
sine- am sin dy inc
sine- da the ob for
sine- ne mo sy ida
sine- sio sta

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